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POWER

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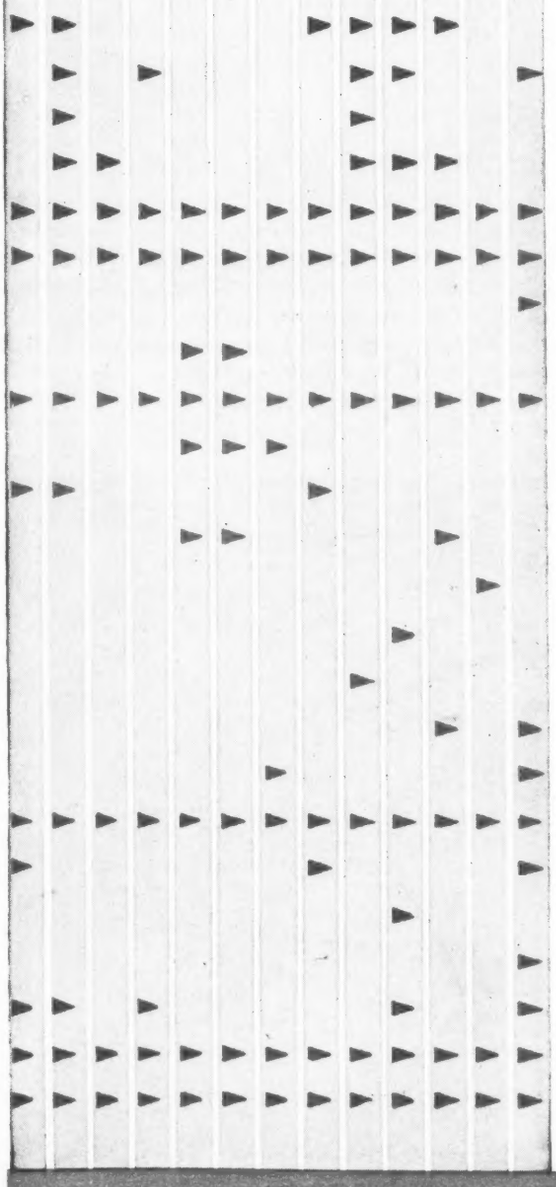
POWER TOPICS CROSS-INDEX

STEAM GENERATION · POWER GENERATION · WATER POWER · DIESEL & GAS ENGINES · AIR CONDITIONING & HEATING · REFRIGERATION · PUMPS & COMPRESSORS · STEAM SERVICES · ELECTRICITY & ELEVATORS · INSTRUMENTS & CONTROL · PIPING SYSTEMS · MECHANICAL TRANSMISSION · POWER MISCELLANY



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To reduce corrosion losses

PRATT & LAMBERT plant engineer ... uses WROUGHT IRON

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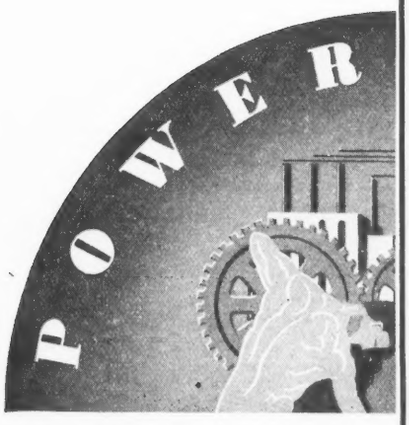


A McGraw-Hill Publication—Established 1882
PHILIP W. SWAIN, *Editor*

Wheels Turn

EVERYWHERE wheels are turning. The 1936 production of auto trucks, refrigerating equipment, rayon, washing machines, oil burners, cigarettes, gasoline and footwear is the highest in history. Automobile manufacturers turn out 4.5 million passenger cars—three times as many as in 1932 and 83% of the 1929 production.

Farm income, which dropped from 10.5 billion dollars in 1929 to 4.3 in 1932, is back to 7.8 billions. Construction rises to 5.5 billions from the 2.8 billions of 1932.

Chemical production stands at 1929 levels. Textile activity is 50% above 1932 and 10% above 1929. Sales of industrial machinery are nearly five times those of 1932.

Employment is much higher, particularly in the skilled trades. Engineering staffs are up 150% and metal trades employment 50%. Carloadings practically double 1932 levels. Consumer goods move at 90% of the 1929 gait, as against 70% in 1932. Capital-goods activities, which crept along at 40% of 1929 in 1932, now walk without crutches at 70% and are getting ready for a sensational sprint. Both national income and employment in the manufacturing industries have climbed halfway back from the toboggan ride of 1929–1932.

Looking closer home, we find the utilities generating 110 billion kw.-hr. in 1936. The 1929 figure was only 91.4 billions. It's safe to add another 15% for 1937. Money spent for new utility generating equipment rises to 125 millions in 1936, with 200 millions predicted for 1937.

Air conditioning, expanding rapidly, places new burdens on water systems, directs anxious attention to the efficiency and capacity of pumping stations. Meanwhile such lines as fans, ductwork, coolers and heaters, refrigerators, washers and filters feel the impact.

The railroads, hit on the head with a 2-cent mandatory rate, miraculously come to life, offer more service than ever at the lowest price in history, bulge with new passengers pampered with unheard-of mechanical comforts.

Power in industry crept through the depression, but never halted. Today it steps out. The steam-plant tabulation in this number lists nearly twice as many plants as we reported last year.

Looking ahead, the most competent business observers can see nothing but steady expansion for two years at least. Conservative estimators foresee another 10 to 15% increase in consumer-good industries in 1937 and from 25 to 30% increase in capital goods—in short a real boom.

But this bright picture has its cloudy side. What about an increase in boiler explosions and other accidents to run-down depression equipment forced to carry the load of renewed prosperity? What about depleted engineering organizations suddenly called upon to expand forces and equipment simultaneously? What about plans half-baked for lack of time, of deliveries of essential equipment delayed because everybody gets the bright idea at the same time? What about all these new engineering developments to be studied when we'll be too busy to study?

These are times when fifteen days make a difference to power engineers. So we present our review of the year now instead of in January. And we suggest that now, rather than in January, readers lay their technical plans for the new year—plans for modernizing, for getting jobs under way at the earliest moment, plans for enlarging and training staff, plans for selling the management in time, plans for organizing personal affairs to make time for real executive control of the power job.

STEAM PLANTS

Additions to existing plants; superposition units; larger capacity high-speed turbines; development of a compact automatic boiler plant complete with auxiliaries

DURING the past year, over twice as many central stations and industrial plants added boilers or turbines to their power facilities as in any year since 1930. In spite of this increased construction activity, only two completely new utility plants have been started, one a 20,000-kw. unit being built by Arkansas Power & Light Co. and one of 10,000 kw. by Potomac Edison Co.

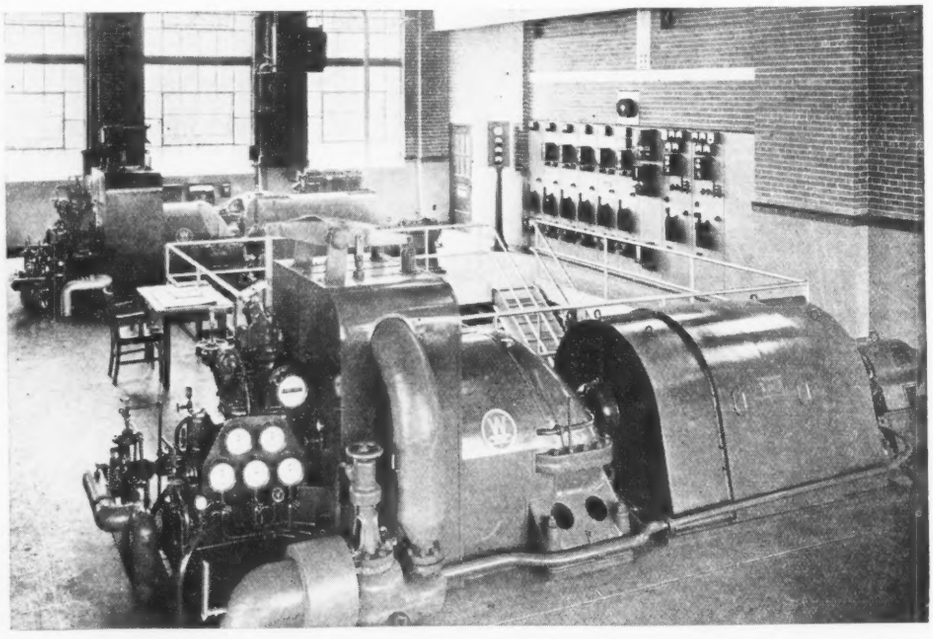
As predicted in *Power*, September, 1934, utilities added to existing plants and superposed high-pressure units on existing lower-pressure stations rather than build new plants. About 770,000 kw. of generating capacity was ordered for central stations this year, as compared with 597,450 kw. ordered and installed last year. Relatively little of this capacity, however, went into operation this year, the only large unit being a 60,000-kw. addition to the Connors Creek station of Detroit Edison Co., Kansas City Power & Light placed a 30,000-kw. unit in operation, and Utah Power & Light started an 18,750-kw. unit in a new plant.

Of the 39 central stations listed in the Table of Power Plant Construction, nine are installing superposition units operating at over 1,200 lb. pressure and 900 deg. One is designed for 900 lb. and ten for pressures ranging from 625 to 860 lb. Thus it seems that those who advocate modernization by superposition of high-pressure units are about equal in number to those who prefer modernization with medium high pressure.

A somewhat larger number of municipal plants are under construction than in previous years, 89,500 kw. of capacity having been ordered this year. It is significant that none have been designed for over 450 lb. pressure. Apparently municipal plants are not taking advantage of the higher economy possible with high pressures, as have both central stations and industrial plants.

The Ford Motor Co.'s 110,000-kw. vertical compound unit was the only 1,200-lb. industrial unit to go in operation, and none are now under construction. Nevertheless, at least 19 industrials are installing power equipment for operation at pressures over 500 lb. Two of these designed for 900 lb. went into operation, one a 6,250-kw. unit at the Barberton plant of Pittsburgh Glass Co. and the other a 10,000-kw. unit at Wierton Steel Co. Standard Oil Co. of Calif. started construction of a 4,000-kw. unit to operate at 850 lb. and 760 deg.

Several industrials are installing relatively large units. Carnegie-Illinois Steel Co. ordered a 25,000-kw. unit to operate at 450 lb. pressure and 750 deg. Jones & Loughlin Steel Co. is putting in a 20,000-kw. unit at South Chicago, and Dow Chemical a 10,000-kw. unit. Hershey Chocolate Co. placed in operation a 10,000-kw. unit operating at 475 lb. and 650 deg.



Fort Collins, Colo., municipal plant has two 1500-kw. units operating at 400 lb.

This year up to October, industrials ordered 251,000 kw. of turbine and engine-generator capacity as compared with 303,400 kw. last year. These capacity figures, however, do not give a true picture of power activity among industrials, because last year's capacity was greatly swelled by the 110,000-kw. Ford turbine (not included in this year's capacity figures although the unit went into operation this year).

During the year, operating data on Port Washington Station became available. This is the only new large central station placed in operation in the past few years, hence its performance is the only available measure of the advances in economy of new plants.

Figures for the first 10 months of operation indicate this plant has a heat rate of 10,900 B.t.u. per net kw.-hr. This is the lowest heat rate of any plant operating on a steam cycle, and with a thermal efficiency of 31.3% it practically equals diesel economy. It has been said this highly efficient plant cost only about $90 per installed kilowatt.

Steam Generation

Outstanding in the field of steam generation has been the development of the "Steamotive" unit, a complete automatic boiler plant with its auxiliaries designed to meet small space requirements. This boiler is arranged for forced circulation. Units capable of generating 22,000 lb. of steam per hr. can be loaded on a single flatcar and shipped completely assembled. One such unit is operating at 1,500 lb. pressure and 900 deg. at the Lynn works of General Electric Co. Another unit of 10,000 lb. per hr. capacity together with a turbo-generator is scheduled for operation this month at the Northville, Mich., plant of Ford Motor Co. and two of 40,000 lb. per hr. have been bought by the Union Pacific R.R. This development makes available for the first time a complete power plant that can be purchased in much the same way as one buys an automobile. It may eventually lead to lower-cost power plants installed with a minimum of construction work.

During the year, there have been several straight-through-single-pass boilers installed. These boilers include economizers and damper arrangements for superheat control. Such a unit is being installed at the Millers Ford plant of Dayton Power & Light Co. Generating 375,000 lb. of steam an hr. at 1,250 lb. pressure, the boiler has only five rows of main boiler tubes. A sixth row forms a vertical water-cooled baffle, with superheater one side and economizer on the other. Dampers at the boiler outlet control the flow of gas through these two passes and hence can control superheat. Another unusual boiler is that for the Cedar Rapids plant of Iowa Electric Light & Power Co. This unit has a central water-wall in the furnace to decrease furnace temperature so that low-fusion-ash coals can be burned at high combustion rates. No exceptionally large boilers have been ordered, the largest generating 575,000 lb. per hr. at 1,450 lb. pressure for the "top" at Springdale. An eastern industrial has ordered a Velox boiler of 50,000 lb. per hr. capacity.

Progress in construction of 3,600-r.p.m. turbines has gone ahead by leaps and bounds. In 1934, the largest-capacity unit operating at this speed was the 18,000-kw. turbine at Burlington station of Public Service Electric & Gas Co. Last year the capacity of this type of turbine was more than doubled by a 40,000-kw., 3,600-r.p.m. turbine ordered by Appalachian Electrical Power Co. for Logan. This year the capacity has been increased 50% by two 60,000-kw., 3,600-r.p.m. turbines ordered for Windsor. Another record turbine is a 25,000-kw., single-cylinder, 3,600-r.p.m. unit for Connecticut Light & Power Co. This is the largest high-speed condensing unit.

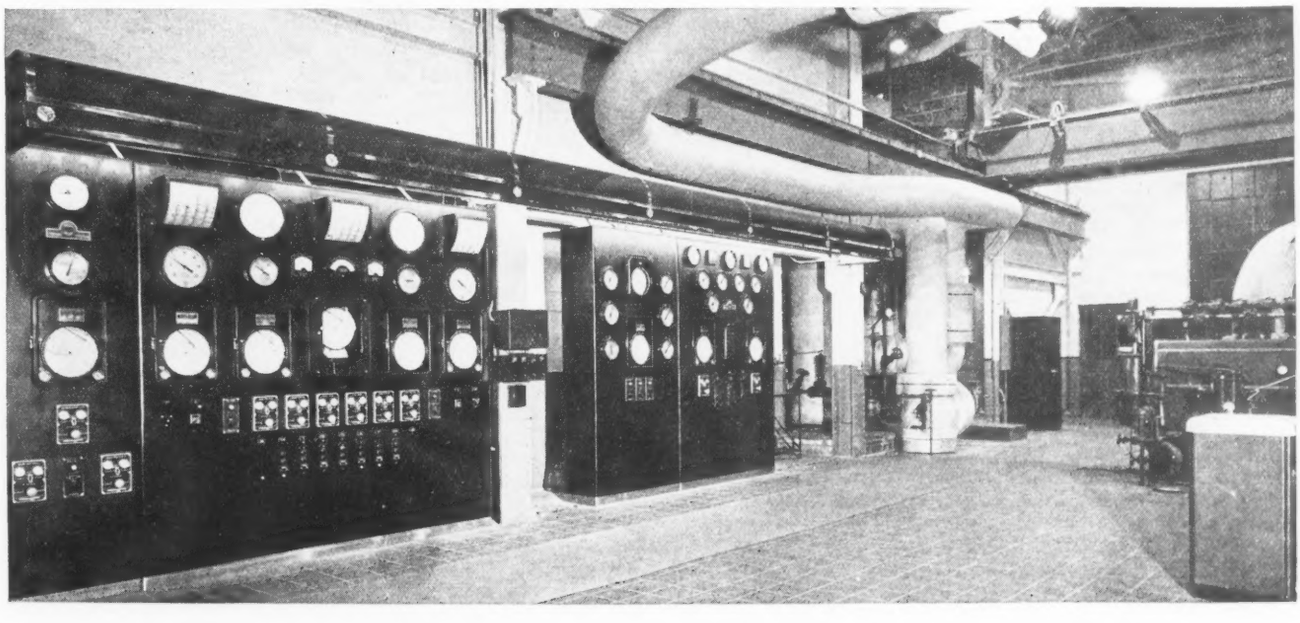
Two factors have led to this development of high-speed turbines, one the high inlet steam conditions and the other hydrogen cooling of the generator.

The 50,000-kw., 3,600-r.p.m. superposition turbine for New York Edison Co. is outstanding because it embodies two separately controlled turbines on the same shaft. The main turbine capacity is 46,700-kw. and is controlled either by the speed governor or main exhaust pressure. The feedwater-heating turbine capacity is 3,300-kw. and is controlled to maintain constant exhaust pressure of 5 lb. and gives control of feedwater heating, independent of load on the main unit. This arrangement is particularly helpful when suitable bleeder connections cannot be provided in the older low-pressure turbines for which superposition may be desirable.

For high-temperature, high-pressure turbines one manufacturer is using carbon-molybdenum steel for the cylinders and another has gone to a jacketed construction to decrease the temperature gradient on parts subjected to initial steam conditions. Shrouded blading is being used increasingly on reaction turbines, thus eliminating lashing wires.

Turbines ordered during the year indicate a trend to units of moderate capacity, the average size being 20,000 kw. and the largest being a 75,000-kw. unit ordered for Cahokia.

Controls for the 6,000-kw. "top" at Rochester No. 3 are centralized on these two meter boards



STEAM PLANTS PLACED IN OPERATION

Compiled by R. B. PURDY, *Associate Editor*

Company	Location	Date of 1st Oper.	Boiler: Pressure, Lb. per Sq. In.	Boiler: Temperature, Deg. F.	Boiler: Number of Boilers	Boiler: Steaming Capacity, Lb. per Hr. Each	Boiler: Heating Surface—Sq. Ft. Each	Water Wall Surface—Sq. Ft. Each	Economizer: Number	Economizer: Surface, Sq. Ft. Ea.	Air Preheater: Number	Air Preheater: Surface, Sq. Ft. Ea.	Furnace Volume, Cu. Ft.
UTILITY PLANTS													
West Penn. Power Co.	Springdale, Pa	....	1,450	935	3	575,000	6,200	5,286	3	22,430	3	32,630	15,450
New York Edison (waterside)	New York, N. Y.	....	1,400	900	2	500,000	7,005	5,184	1	18,850	2	32,700	20,400
Dayton Power & Light Co.	Millers Ford	....	1,375	900	2	375,000	.....	.....	..	.....	..	.....	.....
Nebraska Power Co.	Omaha, Neb.	....	1,350	910	1	271,000	12,000	3,550	1	18,130	2	12,250	10,800
Appalachian Electric Power Co.	Logan, W. Va.	....	1,250	925	1	1,000,000	20,800	20,300	2	25,850	2	45,200	41,000
Ohio Power Co.	Windsor, W. Va.	....	1,250	925	..	.....	.....	.....	..	.....	..	.....	.....
West Penn Elec. Co.	Windsor, W. Va.	....	1,250	925	..	.....	.....	.....	..	.....	..	.....	.....
Commonwealth Edison Co.	Chicago, Ill.	....	1,200	900	2	412,500	6,640	5,070	1	12,000	1	56,200	15,870
Cincinnati Gas & Electric Co.	Cincinnati, Ohio	1937	1,200	900	3	350,000	.....	7,176	3	15,031	3	34,800	4,750
Consumers Power Co.	Battle Creek, Mich	....	900	875	1	360,000	4,134	6,254	1	20,112	1	67,733	19,830
Virginia Electric & Power Co.	Richmond, Va.	....	860	835	1	450,000	24,800	11,000	..	.....	2	32,200	20,000
Tucson Gas & Elec. Light & Power	Tucson, Ariz.	....	825	825	1	75,000	4,727	1,774	..	.....	1	5,500	2,855
Iowa Electric Light & Power Co.	Cedar Rapids, Iowa	....	750	765	1	300,000	13,600	7,137	1	4,508	1	20,500	7,500
Connecticut Light & Power Co.	Montville, Conn.	....	725	825	2	130,000	9,140	2,610	..	.....	2	19,400	6,200
Virginia Public Service Co.	Alexandria, Va.	....	725	....	1	.....	6,450	.....	..	.....	..	.....	.....
Detroit Edison Co. (Connors Creek)	Detroit, Mich.	1936	710	850	2	420,000	26,190	2,480	4	8,490	4	28,980	11,000
Holyoke Water Power	Holyoke, Mass.	....	675	750	1	170,000	.....	.....	..	.....	..	.....	.....
Rochester Gas & Elec. Corp.	Rochester, N. Y.	....	660	750	1	250,000	15,300	3,990	1	20,808	..	.....	13,720
Pacific Gas & Electric Co.	Eureka, Calif.	....	650	750	1	50,000	5,150	642	..	.....	..	.....	2,183
Indianapolis Power & Light Co.	Indianapolis, Ind.	....	623	750	..	.....	.....	.....	..	.....	..	.....	.....
United Illuminating Co.	Steel Point, Conn.	....	625	850	2	125,000	11,100	.....	..	.....	2	10,320	5,900
Louisville Gas & Electric Corp.	Louisville, Ky.	1937	450	750	..	.....	.....	.....	..	.....	..	.....	.....
Utah Power & Light Co.	.....	....	450	....	1	.....	.....	.....	..	.....	..	.....	.....
Lynn Gas & Electric Co.	Lynn, Mass.	1936	430	810	1	205,000	14,995	5,900	..	.....	2	7,900	11,700
Laclede Power & Light Co.	Mound St., St. Louis, Mo.	....	425	850	..	.....	13,500	.....	..	.....	..	.....	.....
Central Maine Power Co.	Bucksport, Me.	....	400	725	..	.....	.....	.....	..	.....	..	.....	.....
Savannah Electric & Power Co.	Savannah, Ga.	1936	400	700	..	.....	.....	.....	..	.....	..	.....	.....
Springfield Water, Light & Power	Springfield, Ill.	1936	400	700	1	100,000	10,770	1,550	..	.....	1	.....	7,150
Houston Lightning & Power Co.	Houston, Tex.	....	365	700	..	.....	.....	.....	..	.....	..	.....	.....
Union Electric Light & Power Co.	St. Louis, Mo.	1937	350	700	5	260,000	18,010	3,500	..	.....	1	9,900	13,500
Public Service Co. of Colorado	Denver, Col.	....	350	750	..	.....	.....	.....	..	.....	..	.....	.....
Northern States Power Co.	Minot, N. D.	1936	325	725	1	54,000	7,160	.....	..	.....	..	.....	3,700
A. T. & S. F. R. R. (18th St. Sta.)	Chicago, Ill.	1937	250	....	3	16,200	3,590	.....	..	.....	..	.....	1,080
Missouri Utilities Co.	Cape Girardeau, Mo.	....	250	505	1	40,000	5,340	800	..	.....	..	.....	1,300
Virginia Electric & Power Co.	Norfolk, Va.	....	225	....	2	32,600	3,100	.....	..	.....	..	.....	8,000
Iowa Public Service Co.	Eagle Grove, Ia.	....	200	....	2	22,500	.....	.....	..	.....	..	.....	.....
St. Joseph Ry., Light, Heat & Pwr. Co.	St. Joseph, Mo.	1936	175	478	..	.....	.....	.....	..	.....	..	.....	.....
San Diego Consol. Gas & Elec. Co.	San Diego, Cal.	....	....	....	2	200,000	.....	.....	..	.....	..	.....	.....
Mount Carmel Public Utilities	Mount Carmel, Ill.	....	....	....	..	.....	.....	.....	..	.....	..	.....	.....
MUNICIPAL PLANTS													
City of Kansas City	Kansas City, Kan.	....	450	750	1	180,000	.....	.....	..	.....	..	.....	.....
City of Rocky Mount	Rocky Mount, N. C.	....	450	725	1	100,000	10,500	625	..	.....	..	.....	3,000
City of Springfield	Springfield, Ill.	1936	450	714	1	112,000	9,220	1,550	..	.....	1	11,950	7,150
Borough of Vineland	Vineland, N. J.	1936	450	750	1	96,000	7,900	283	..	.....	1	4,536	.....
Fort Collins	Fort Collins, Colo.	1936	425	700	2	25,000	3,950	175	..	.....	..	.....	1,451
City of Marshall	Marshall, Mo.	....	425	725	1	24,000	3,250	54	..	.....	..	.....	.....
City of Austin	Austin, Minn.	....	420	750	1	80,000	9,250	1,367	..	.....	1	11,350	4,000
City of Marshfield	Marshfield, Wis.	....	400	650	1	40,000	6,170	250	..	.....	..	.....	.....
City of Rock Rapids	Rock Rapids, Ia.	....	400	699	2	16,000	3,100	81	..	.....	..	.....	.....
City of Hamilton	Hamilton, Ohio	....	350	675	..	.....	.....	.....	..	.....	..	.....	.....
City of Atlantic	Atlantic, Ia.	....	250	506	1	13,500	.....	.....	..	.....	..	.....	.....
City of South Haven	South Haven, Mich.	....	250	....	..	.....	.....	.....	..	.....	..	.....	.....
Municipal Light & Power	Troy, Ohio	....	250	600	1	50,000	6,448	.....	..	.....	..	.....	.....
City of Decatur	Decatur, Ind.	....	200	500	4	38,000	.....	.....	..	.....	..	.....	.....
City of Stillwater	Stillwater, Okla.	....	200	488	2	60,000	.....	.....	..	.....	..	.....	.....
City of Wellington	Wellington, Kan.	....	200	488	..	31,000	.....	.....	..	.....	..	.....	.....
Village of Montpelier	Montpelier, Ohio	....	165	475	..	.....	.....	.....	..	.....	..	.....	.....
Village of Blissfield	Blissfield, Mich.	....	165	473	..	.....	.....	.....	..	.....	..	.....	.....
Madison Municipal Plant	Madison, Minn.	....	150	....	3	.....	3,592	.....	..	.....	..	.....	.....
City of Breese	Breese, Ill.	1936	140	....	..	.....	.....	.....	..	.....	..	.....	.....
INSTITUTIONAL PLANTS													
R. I. State Hospital	Howard, R. I.	....	450	600	2	60,000	6,140	1,920	..	.....	1	5,000	2,750
University of Minnesota	Minneapolis, Minn.	....	307	625	1	100,000	8,500	2,180	..	.....	1	8,100	7,000
Missouri State Sanitarium	Mt. Vernon, Mo.	....	250	....	2	11,700	.....	.....	..	.....	..	.....	.....
Missouri State Hospital No. 2	Farmington, Mo.	....	250	....	2	15,750	.....	.....	..	.....	..	.....	.....
University of Texas	Austin, Texas	....	250	500	1	60,000	6,050	.....	..	.....	1	3,780	.....
Wallum Lake Sanitorium	Wallum Lake, R. I.	....	250	....	1 1	....	1,750 2,500	.....	..	.....	..	.....	.....
Boston City Hospital	Boston, Mass.	....	225	500	1	42,000	6,000	.....	..	.....	..	.....	2,400
Metropolitan Hospital	New York, N. Y.	....	200	....	4	.....	3,040	.....	..	.....	..	.....	.....
State School for Feeble-Minded	Redfield, S. D.	....	200	....	1	30,000	3,750	.....	..	.....	..	.....	900
University of Oklahoma	Norman, Okla.	....	200	538	1	50,000	6,040	.....	..	.....	1	2,620	3,024
University of Tennessee	Knoxville, Tenn.	....	200	437	1	75,000	6,514	1,500	..	.....	1	6,840	2,580
Vocational School	Philadelphia, Pa.	1937	175	....	3	25,800	3,740	.....	..	.....	..	.....	.....
Taunton State Hospital	Taunton, Mass.	1936	165	....	2	12,500	6,200	.....	..	.....	..	.....	.....
Berea College	Berea, Ky.	....	160	366	2 4	....	3,840 2,940	.....	..	.....	..	.....	.....
Kansas State Juvenile Home	Winfield, Kan.	1936	160	....	1	15,750	3,505	.....	..	.....	..	.....	.....
Orange Memorial Hospital	Orange, N. J.	....	160	....	1	.....	2,177	.....	..	.....	..	.....	.....
University of Alabama	Tuscaloosa, Ala.	....	160	....	1	35,000	5,090	.....	..	.....	..	.....	.....
University of New Mexico	Albuquerque, N. M.	....	160	....	2	20,000	3,189	.....	..	.....	..	.....	900
Vanderbilt University	Nashville, Tenn.	....	160	....	1	40,000	5,838	.....	..	.....	..	.....	.....
Coney Island Hospital	New York, N. Y.	....	160	....	2	.....	2,580	.....	..	.....	..	.....	.....
Rockland State Hospital	Orangeburg, N. Y.	....	140	366	..	34,000	8,600	.....	..	.....	..	.....	.....
David Rankin School of Mec. Trades	St. Louis, Mo.	....	140	....	..	.....	.....	.....	..	.....	..	.....	.....
Kankakee State Hospital, Kankakee, Ill.	Kankakee, Ill.	....	125	....	..	.....	.....	.....	..	.....	..	.....	.....
Illinois School for Boys	St. Charles, Ill.	1936	120	....	2	27,000	4,040	.....	..	.....	..	.....	1,500
Vassar College	Poughkeepsie, N. Y.	....	100	....	..	.....	.....	.....	..	.....	..	.....	.....
GOVERNMENT PLANTS													
Bureau of Docks & Yards	Norfolk, Va.	....	450	....	1	40,000	6,000	.....	..	.....	..	.....	1,880
Norfolk Navy Yard	Norfolk, Va.	....	190	428	..	.....	.....	.....	..	.....	..	.....	.....
U. S. Department of Labor	Ellis Island, N. Y.	....	125	....	..	.....	.....	.....	..	.....	..	.....	.....
U. S. Naval Air Station	Pensacola, Fla.	....	250	605	1	35,000	4,000	.....	..	.....	..	.....	.....

C.T.—Condensing turbine, B.T.—Backpressure turbine, C.E.T.—Condensing extraction turbine, B.E.T.—Backpressure extraction turbine, S.—Stoker,

OR UNDER CONSTRUCTION DURING 1936

Method of Firing	Fans: Forced: Number	Fans: Forced: Capacity, C.F.M., Ea.	Fans: Induced: Number	Fans: Induced: Capacity, C.F.M., Ea.	Boiler Feed Pump: Number	Boiler Feed Pump: Capacity, G.P.M., Ea.	Main Generating Units: Number	Main Generating Units: Type	Main Generating Units: Capacity, Kw., Ea.	Bleed Points: Number	Bleed Points: Pressure, Lb. per Sq. In.	Condenser Surface, Sq. Ft.	Circulating Pump: Number	Circulating Pump: Capacity, G.P.M.	Remarks
P. C.	6	86,000	6	166,000	4	1,554	1	B. T.	50,000	..	.....	.....	..	.....	340-lb. exhaust.
P. C.	2	86,750	2	139,000	3	1,250	1	B. T.	50,000	3	5-60-200	.....	..	.....	200-lb. exhaust
P. C.	2	113,000	2	200,000	..	.....	1	.....	25,000	..	.....	.....	..	.....	235-lb. exhaust.
T. G. S.	1	85,500	2	92,000	2	660	1	B. T.	10,000	..	.....	.....	..	.....	200-lb. exhaust
P. C.	2	145,000	2	274,000	3	1,500	1	B. T.	40,000	..	.....	.....	..	.....	Topping unit.
.....	..	.....	..	.....	..	.....	1	.....	60,000	..	.....	.....	..	.....	235-lb. exhaust
.....	..	.....	..	.....	..	.....	1	.....	60,000	..	.....	.....	..	.....	235-lb. exhaust.
P. C.	1	128,000	1	220,000	3	1,000	1	B. T.	30,000	..	.....	.....	..	.....	235-lb. avs. backpressure.
P. C.	3	95,000	3	170,000	3	1,200	1	B. T.	35,000	..	.....	.....	..	.....	260-lb. exhaust.
P. C.	1	105,000	1	190,000	2	860	1	B. T.	10,000	..	.....	.....	..	.....	210-lb. exhaust.
P. C.	2	78,000	2	155,000	4	800	1	B. T.	12,500	..	.....	.....	..	.....	200-lb. exhaust.
Gas	1	24,000	1	29,300	2	150	1	C. E. T.	5,000	4	.....	5,400	1	7,350	.....
U. S.	1	90,000	1	160,000	1	665	1	B. T.	5,000	..	.....	.....	..	.....	215-lb. exhaust.
P. C.	2	40,000	2	70,000	2	500	1	C. T.	25,000	4	.....	20,000	..	.....	.....
.....	..	.....	..	.....	..	.....	1	.....	5,000	..	.....	4,875	..	.....	.....
U. S.	4	101,000	4	181,000	2	1,320	1	C. E. T.	60,000	3	.....	35,200	2	90,000	.....
Oil	..	.....	..	.....	..	.....	..	.....	.....	..	.....	.....	..	.....	.....
P. C.	1	69,000	1	.....	2	730	1	B. T.	6,000	..	.....	.....	..	.....	210-lb. exhaust.
Hand	1	73,000	..	.....	..	.....	..	.....	.....	..	.....	.....	..	.....	Operating at 200 lb.
.....	..	.....	..	.....	..	.....	1	B. E. T.	2,000	2	60	.....	..	.....	8-lb. exhaust.
							1	B. T.	12,500	..	125	.....	..	.....	245-lb. exhaust.
P. C.	2	35,400	2	75,200	2	580	1	B. T.	5,000	..	.....	.....	..	.....	225-lb. exhaust.
.....	..	.....	..	.....	..	.....	1	C. T.	25,000	..	.....	.....	..	.....	.....
T. G. S.	..	.....	..	.....	..	.....	1	.....	15,000	..	.....	.....	..	.....	.....
P. C.	1	69,000	1	114,000	..	.....	..	.....	.....	..	.....	.....	..	.....	.....
Gas	..	.....	..	.....	3	.....	1	B. T.	5,000	..	.....	.....	..	.....	185-lb. backpressure.
.....	..	.....	..	.....	2	350	1	B. T.	5,000	1	140	.....	..	.....	40-lb. exhaust to Paper Co.
.....	..	.....	..	.....	..	.....	1	C. T.	7,500	2	15–125	7,800	1	11,700	.....
P. C.	1	39,100	1	72,000	..	.....	1	C. E. T.	10,000	2	.....	16,000	..	.....	.....
.....	..	.....	..	.....	..	.....	1	C. E. T.	5,000	1	30	4,700	..	5,000	At plant of Champion Paper Fibre Co.
							1	B. E. T.	4,000	1	135				
P. C.	1	95,000	1	180,000	2	1,800	1	C. E. T.	75,000	3	.....	63,000	2	40,000	.....
.....	..	.....	..	.....	..	.....	1	C. E. T.	25,000	4	.....	30,000	1	36,000	.....
S. S.	..	.....	..	.....	..	.....	..	.....	.....	..	.....	.....	..	.....	Boiler operates at 200 lb.
S.	1	11,700	..	.....	2	240	..	.....	.....	..	.....	.....	..	.....	.....
C. G. S.	1	16,000	..	.....	2	150 / 200	1	C. T.	3,500	1	30	6,000	3	6,000	.....
U. S.	2	10,500	..	.....	..	.....	..	.....	.....	..	.....	.....	..	.....	.....
Gas	..	.....	..	.....	1	90	1	C. E. T.	1,000	1	5	3,500	2	1,488	.....
.....	..	.....	..	.....	1	750	1	C. T.	7,500	..	.....	15,000	2	9,000	.....
.....	..	.....	..	.....	..	.....	1	.....	35,000	..	.....	.....	..	.....	.....
.....	..	.....	..	.....	..	.....	1	C. T.	1,500	3	10 / 25	2,135	1	1,890	.....
.....	..	.....	..	.....	..	.....	1	C. T.	30,000	..	.....	40,000	..	.....	.....
S.	1	45,000	..	.....	..	.....	..	.....	.....	..	.....	.....	..	.....	.....
P. C.	1	39,100	1	72,000	3	250	1	C. E. T.	10,000	3	.....	16,000	1	13,000	.....
U. S.	1	32,300	1	74,500	2	300	1	C. E. T.	4,000	2	35 / 125	5,000	1	7,000	.....
S. S.	2	.....	1	.....	3	50	2	C. T.	1,500	..	.....	2,300	2	1,650	.....
C. G. S.	1	.....	1	.....	1 / 1	90 / 45	1	C. E. T.	1,500	1 / 1	140 / 16	2,500	2	1,975	.....
U. S. Gas-Oil	1	30,000	1	40,000	..	.....	..	.....	.....	..	.....	.....	..	.....	.....
U. S.	1	18,000	..	.....	2	100	1	C. T.	2,500	..	.....	2,888	2	3,000 / 1,700	.....
S. S.	2	.....	..	.....	2	.....	2	C. E. T.	500	1	10	1,150	1	900	
								B. T.	350						
.....	..	.....	..	.....	..	.....	1	T.	10,000	..	.....	.....	..	.....	.....
.....	..	.....	..	.....	..	.....	..	.....	.....	..	.....	.....	..	.....	.....
.....	..	.....	..	.....	2	150	1	C. E. T.	2,000	2	.....	2,800	1	3,500	.....
U. S.	1	24,000	..	.....	..	.....	..	.....	.....	..	.....	.....	..	.....	.....
.....	..	.....	..	.....	..	.....	2	C. T.	2,000	..	.....	3,900	..	.....	.....
Gas-Oil	..	.....	..	.....	2	100	1	C. E. T.	2,500	2	.....	5,000	2	2,700	.....
Gas-Oil	..	.....	..	.....	2	.....	2	C. E. T.	2,000 / 4,250	1	15	7,000	3	7,000	.....
.....	..	.....	..	.....	..	.....	1	C. E. T.	1,000	1	.....	1,600	2	900	.....
.....	..	.....	..	.....	..	.....	1	T.	500	..	.....	.....	..	.....	.....
U. S.	..	.....	..	.....	2	100	3	Eng.	425	..	.....	.....	..	.....	5-lb. exhaust.
.....	..	.....	..	.....	..	.....	1	Eng.	300	..	.....	.....	..	.....	.....
Oil	1	2,200	1	3,300	3	150	2	B. E. T.	750	1	100	.....	..	.....	.....
P. C.	1	30,000	1	59,300	1	600	..	.....	.....	..	.....	.....	..	.....	.....
.....	..	.....	..	.....	..	.....	1	Eng.	150	..	.....	.....	..	.....	.....
.....	..	.....	..	.....	..	.....	..	.....	.....	..	.....	.....	..	.....	.....
S.	1	20,300	1	39,700	..	.....	1	C. E. T.	2,500	1	50	.....	..	.....	.....
Oil	..	.....	..	.....	..	.....	2	B. E. T.	200	1	100	.....	..	.....	.....
Oil	..	.....	..	.....	1	415	1	B. T.	600	..	.....	.....	..	.....	.....
.....	..	.....	..	.....	..	.....	..	.....	.....	..	.....	.....	..	.....	.....
S.	1	19,000	..	.....	..	160	..	.....	.....	..	.....	.....	..	.....	New chimney.
Gas	..	.....	..	.....	..	.....	1	.....	625	1	1	.....	..	.....	.....
P. C.	1	21,500	1	40,500	1	250	..	.....	.....	..	.....	.....	..	.....	.....
C. G. S.	2	24,000	..	.....	2	.....	1 / 2	Eng.	300 / 500	..	.....	.....	..	.....	5-lb. exhaust.
Oil	..	.....	..	.....	3	100	..	.....	.....	..	.....	.....	..	.....	.....
U. S.	..	.....	..	.....	..	.....	3	C. E. T.	1,800	1	50	1,150	1	1,500	.....
Gas	..	.....	..	.....	..	.....	..	.....	.....	..	.....	.....	..	.....	.....
Oil	1	10,000	..	.....	..	.....	..	.....	.....	..	.....	.....	..	.....	.....
S	..	.....	..	.....	..	.....	..	.....	.....	..	.....	.....	..	.....	.....
Gas	1	8,000	1	17,100	1	50	..	.....	.....	..	.....	.....	..	.....	.....
S.	..	.....	..	.....	1	235	..	.....	.....	..	.....	.....	..	.....	.....
.....	..	.....	..	.....	..	.....	..	.....	.....	..	.....	.....	..	.....	.....
U. S.	..	.....	..	.....	1	350	1	B. T.	1,250	..	.....	.....	..	.....	Plant addition.
.....	..	.....	..	.....	..	.....	1	Eng.	150	..	.....	.....	..	.....	5-lb. exhaust.
.....	..	.....	..	.....	..	.....	1 / 1	Eng.	200 / 400	..	.....	.....	1	300	2-lb. exhaust.
S.	2	10,000	..	.....	..	.....	..	.....	.....	..	.....	.....	..	.....	.....
.....	..	.....	..	.....	..	.....	1	B. T.	250	..	.....	.....	..	.....	4-lb. exhaust.
Oil	1	1,800	1	2,400	..	.....	..	.....	.....	..	.....	.....	..	.....	Temporary operation at 125 lb.
.....	..	.....	..	.....	..	.....	1	C. E. T.	6,000	1	20	10,000	..	.....	.....
.....	..	.....	..	.....	..	.....	1	B. T.	400	..	.....	.....	..	.....	4-lb. exhaust.
Gas-Oil	1	13,500	1	40,000	..	.....	..	.....	.....	..	.....	.....	..	.....	.....

U.S.—Underfeed stoker, T.G.S.—Traveling-grate stoker, C.G.S.—Chain-grate stoker, S.S.—Sprinkler stoker, P.C.—Pulverized coal

PLANTS PLACED IN OPERATION OR

Company	Location	Date of 1st Oper.	Boiler: Pressure, Lb. per Sq. In.	Boiler: Temperature, Deg. F.	Boiler: Number of Boilers	Boiler: Steaming Capacity, Lb. per Hr. Each	Boiler: Heating Surface—Sq. Ft. Each	Water Wall Surface—Sq. Ft. Each	Economizer: Number	Economizer: Surface, Sq. Ft. Ea.	Air Preheater: Number	Air Preheater: Surface, Sq. Ft. Ea.	Furnace Volume, Cu. Ft.
INDUSTRIAL PLANTS													
Pittsburgh Plate Glass Co	Barberton, Ohio	1936	900	750	1	180,000	15,147	1,800	1	8,247	..	.....	.....
Weirton Steel Co	Weirton, W. Va	1936	900	815	2	400,000	20,487	4,277	..	.....	1	49,500	17,280
Standard Oil of California	Richmond, Cal	....	850	760	3	125,000	.....	.....	..	.....	..	.....	.....
Gulf Refining Co	Port Arthur, Tex	....	725	676	2	200,000	15,740	.....	..	.....	2	25,500	7,255
Hammermill Paper Co	Erie, Pa	....	725	775	2	80,000	8,490	.....	..	.....	2	9,460	.....
Monsanto Chemical Co	St. Louis, Mo	....	725	700	2	100,000	10,400	930	2	1,843	2	6,820	4,110
Consolidated Ashcroft, Hancock Co	Bridgeport, Conn	....	700	....	1	24,000	.....	.....	..	.....	..	.....	.....
Postum Co., Inc	Battle Creek, Mich	....	700	720	1	115,000	10,800	1,630	..	.....	1	9,500	4,916
Gulf Oil Corp. of Penn	Pittsburgh, Pa	....	650	647	..	200,000	15,740	.....	..	.....	2	25,500	.....
Shell Oil Co	San Francisco, Cal	....	650	695	1	70,000	5,210	700	..	.....	1	565	2,360
Tennessee Eastman Corp	Kingsport, Tenn	....	650	700	2	135,000	11,424	1,170	2	2,950	2	7,350	6,050
Cleveland Worsted Mills Co	Cleveland, Ohio	....	616	500	1	120,000	7,680	1,800	..	.....	1	11,950	5,304
E. I. Dupont de Nemours & Co	Buffalo, N. Y	....	600	750	1	120,000	10,170	2,234	..	.....	1	9,550	6,744
Glen Alden Coal Co	Ashley, Pa	....	600 125	635	4	48,500	6,154	132	..	.....	..	.....	2,430
W. Va. Pulp & Paper Co	Williamsburg, Pa	1936	600	700	2	73,400	7,400	3,200	..	.....	..	5,000	6,200
Commonwealth Ice & C. S. Co	Boston, Mass	....	575	700	..	.....	.....	.....	..	.....	..	.....	.....
Carnegie-Illinois Steel Corp	Youngstown, Ohio	....	525	690	2	150,000	17,700	2,465	2	1,400	2	15,360	11,300
Carnegie-Illinois Steel Corp	Youngstown, Ohio	....	525	690	2	150,000	17,200	2,088	2	3,770	2	22,520	11,040
Filer Fibre Co	Filer City, Mich	....	500	500	1	90,000	7,160	.....	..	.....	1	.....	.....
Shell Petroleum Corp	Houston, Tex	....	490	....	2	120,000	10,110	2,265	..	.....	..	.....	6,200
Hershey Chocolate Co	Hershey, Pa	1936	475	650	1	170,000	11,650	1,914	..	.....	1	21,130	7,200
Jones & Laughlin Steel Co	Eliza Furnace Pitt, Pa	....	475	725	1	400,000	25,855	4,065	..	.....	1	40,750	18,500
Buick Motor Co	Flint, Mich	....	450	429	4	150,000	12,067	.....	..	.....	4	.....	6,120
Byron Weston Co	Dalton, Mass	....	450	600	1	45,000	4,503	.....	..	.....	1	6,340	1,691
Carnegie-Illinois Steel Corp	S. Chicago, Ill	....	450	750	3	300,000	.....	.....	3	.....	3	.....	.....
E. I. Dupont de Nemours & Co	Belle, W. Va	1937	450	625	2	75,000	6,140	2,200	..	.....	2	6,440	3,790
E. I. Dupont de Nemours & Co	Amphill, Va	....	450	716	1	120,000	9,496	2,846	1	565	1	12,980	7,960
Lanett Bleachery & Dye Wks	Lanett, Ala	....	450	580	1	60,000	7,273	.....	..	6,050	..	.....	3,407
Niagara Alkali Co	Niagara Falls, N. Y	1936	450	460	2	64,900	6,223	.....	..	.....	1	6,300	2,518
Pan-American Refining Corp	Texas City, Tex	....	450	....	2	104,000	13,600	.....	..	.....	2	7,240	6,000
Sylvania Industrial Corp	Fredericksburg, Va	....	450	....	1	60,000	6,370	431	1	1,910	1	910	2,018
Union Bag & Paper Co	Savannah, Ga	1936	450	735	3	43,750	4,785	.....	..	.....	3	2,225	.....
		1936	450	735	3	33,700	3,425	.....	3	2,650	3	3,980	.....
		1937	450	735	2	50,000	5,265	.....	2	.....	..	.....	.....
					2	75,000	8,294	.....	..	.....	2	.....	.....
Union Pacific Coal Co	Rock Springs, Wyo	1936	450	710	2	75,000	8,626	850	..	.....	..	.....	4,055
Wilshire Oil Co	Santa Fe Springs, Cal	....	450	....	4	45,000	3,610	.....	..	.....	..	.....	6,440
Viscose Co	Marcus Hook, Pa	....	425	750	3	125,000	9,030	2,280	..	.....	3	12,100	7,000
Beckett Paper Co	Hamilton, Ohio	....	400	....	2	28,200	3,140	.....	..	.....	..	.....	.....
Dow Chemical Co	Midland, Mich	....	400	700	..	.....	.....	.....	..	.....	..	.....	.....
Spring Cotton Mills	Lancaster, S. C	1937	400	700	1	67,500	.....	.....	1	5,000	..	.....	.....
Amer. Cyanamid & Chem. Co	Bridgeville, Pa	....	350	438	1	100,000	9,346	.....	..	.....	..	.....	4,469
Spreckels Sugar Co	Woodland, Calif	1937	320	520	2	100,000	8,700	910	..	.....	2	5,100	4,200
American Can Co	Marwood, Ill	....	300	....	2	75,000	8,280	930	..	.....	..	.....	3,600
Imperial Paper & Color Co	Glens Falls, N. Y	1936	300	....	2	50,000	6,000	.....	2	1,600	..	.....	1,200
Tubize Chatillon Corp	Rome, Ga	....	285	645	1	45,000	5,128	223	..	.....	..	.....	.....
Bemis Brothers Bag Co	Peoria, Ill	1937	275	600	1	70,000	8,430	3,300	..	.....	..	.....	4,800
Guide Lamp Co	Anderson, Ind	....	275	577	1	50,000	6,300	.....	..	.....	..	.....	.....
Simplex Wire & Cable Co	Cambridge, Mass	....	275	400	1	24,000	2,742	.....	..	.....	..	.....	1,450
Southern Extract Co	Knoxville, Tenn	....	275	414	..	.....	.....	.....	..	.....	..	.....	.....
Aluminum Co. of America	Pittsburgh, Pa	1937	250	456	1	120,000	18,000	876	..	.....	..	.....	.....
Collins & Aikman Corp	Phila., Pa	1936	250	....	1	55,000	6,450	2,110	..	.....	..	.....	4,080
Dougherty Refinery	Petrolia, Pa	....	250	....	1	35,900	.....	.....	..	.....	..	.....	.....
Gonic Mfg. Co	Gonic, N. H	....	250	500	1	35,000	4,377	.....	..	.....	..	.....	6,250
St. Regis Kraft	Tacoma, Wash	....	250	433	1	65,000	8,250	985	..	.....	1	6,996	4,400
Servel, Inc	Evansville, Ind	1936	250	....	2	50,000	6,880	.....	..	.....	..	.....	1,900
Sucrest Corp	Brooklyn, N. Y	....	250	550	2	35,000	4,377	475	..	.....	1	.....	1,691
United Refining Co	Warren, Pa	....	250	400	2	55,000	5,800	750	..	.....	..	.....	3,220
Van Brunt Mfg. Co	Horicon, Wis	1936	236	....	1	21,000	3,230	.....	..	.....	..	.....	.....
Agar Mfg. Co	Chicago, Ill	1936	225	....	1	.....	2,370	.....	..	.....	..	.....	.....
Crowell Publishing Co	Springfield, Ohio	....	225	600	1	300,000	12,680	660	1	6,912	..	.....	4,800
Firestone Tire & Rubber Co	Akron, Ohio	....	225	....	1	23,000	4,815	.....	..	.....	..	.....	.....
Heekin Can Co	Norwood, Ohio	1936	225	395	1	25,000	3,500	.....	..	.....	..	.....	900
John Deere Tractor Co	Waterloo, Iowa	....	225	....	1	45,000	6,750	1,000	..	.....	..	.....	1,060
Shell Oil Co	San Francisco, Cal	....	225	488	17	14,000	2,375	.....	..	.....	..	.....	900
Syracuse Chilled Plow Co	Syracuse, N. Y	1936	225	473	1	17,200	.....	.....	..	.....	..	.....	.....
Shell Oil Co	San Francisco, Cal	....	210	488	1	54,000	6,920	140	..	.....	..	.....	3,110
Brehm & Stehle	Phila, Pa	....	200	....	1	30,000	4,340	.....	..	.....	..	.....	.....
Caterpillar Tractor Co	Peoria, Ill	....	200	....	1	40,000	6,150	.....	..	.....	..	.....	.....
Shell Oil Co	San Francisco, Cal	....	200	488	2	10,000	2,000	.....	..	.....	..	.....	700
Columbia Mills, Inc	Minetta, N. Y	....	185	500	..	.....	.....	.....	..	.....	..	.....	.....
Empire Trust Bldg	New York, N. Y	....	185	....	2	14,000	2,250	.....	..	.....	..	.....	.....
Ice Club	New York, N. Y	....	185	....	1	.....	1,670	.....	..	.....	..	.....	.....
Sonoco Products Co	Hartsville, S. C	....	185	....	..	.....	.....	.....	..	.....	..	.....	.....
Conway Building	Chicago, Ill	....	180	....	4	22,000	3,020	.....	..	.....	..	.....	.....
Julius Breckwolelt & Son, Inc	Dolgeville, N. Y	1936	180	....	1	.....	2,850	.....	..	.....	..	.....	.....
Muscogee Mfg. Co	Columbus, Ga	....	180	....	1	63,000	7,375	.....	..	.....	..	.....	.....
United Dairy Co	Barnesville, Ohio	....	180	....	1	17,000	2,500	.....	..	.....	..	.....	49
					1	23,000	3,500	.....	..	.....	..	.....	64
Ellicott Square Bldg	Buffalo, N. Y	1936	175	377	4	5,000	.....	.....	..	.....	..	.....	.....
Port Huron Sulphite & Paper Co	Port Huron, Mich	....	165	375	..	.....	.....	.....	..	.....	..	.....	.....
Chrysler Corp. (Dodge Plant)	Detroit, Mich	....	150	366	1	140,000	9,155	3,025	..	.....	1	12,900	7,920
American Crystal Sugar Co	Rocky Ford, Col	1936	155	....	..	.....	.....	.....	..	.....	..	.....	.....
American Cream Tartar Co	San Francisco, Cal	....	160	371	1	20,000	3,197	.....	..	.....	..	.....	803
Bethlehem Steel Co	Lackawanna, N. Y	1936	160	566	4	30,000	5,080	.....	4	1,900	..	.....	2,010
Benett Creamery	Ottawa, Kan	....	160	....	2	10,260	4,560	.....	..	.....	..	.....	2,106
Continental Mills	Philadelphia, Pa	....	160	....	..	.....	.....	.....	..	.....	..	.....	.....
Detroiter Hotel	Detroit, Mich	....	160	....	2	9,000	1,400	.....	..	.....	..	.....	270
Libby Glass Co	Toledo, Ohio	1936	160	371	1	22,000	3,155	.....	..	.....	..	.....	425
Libby, McNeil & Libby	Walla Walla, Wash	....	160	353	1	.....	3,113	.....	..	.....	..	.....	.....
Libbey-Owens Ford Glass Co	Toledo, Ohio	....	160	382	2	80,000	10,980	.....	..	.....	..	.....	.....
Cliffs Dow Chemical Co	Marquette, Mich	1936	120	....	..	.....	.....	.....	..	.....	..	.....	.....
Lehigh Valley Coal Co	Wilkes-Barre, Pa	....	115	....	..	.....	.....	.....	..	.....	..	.....	.....
Spencer Kellogg & Sons	Buffalo, N. Y	....	160	....	1	10,000	2,114	.....	..	.....	..	.....	.....
E. I. Dupont de Nemours & Co	Niagara, N. Y	1937	130	....	1	70,000	8,470	575	1	2,975	..	.....	3,200
E. I. Dupont de Nemours & Co	Wilmington, Del	1936	125	....	2	45,000	7,000	.....	..	.....	..	.....	.....
E. I. Dupont de Nemours & Co	New Bridge, Ill	1936	125	....	1	30,000	5,000	.....	..	.....	..	.....	2,100
Electromotive Corp	McCook, Ill	....	100	....	2	10,000	3,320	.....	..	.....	..	.....	.....

UNDER CONSTRUCTION DURING 1936

Method of Firing	Fans: Forced — Number	Fans: Forced — Capacity, C.F.M., Ea.	Fans: Induced — Number	Fans: Induced — Capacity, C.F.M., Ea.	Boiler Feed Pump — Number	Boiler Feed Pump — G.P.M., Ea.	Main Generating Units — Number	Main Generating Units — Type	Main Generating Units — Capacity, Kw., Ea.	Bleed Points — Number	Bleed Points — Pressure, Lb. per Sq. In.	Condenser Surface, Sq. Ft.	Circulating Pump — Number	Circulating Pump — Capacity, G.P.M.	Remarks
U. S.	1	70,000	1	120,000	2	400	1	B. E. T.	6,250	1	400				140-lb. exhaust.
P. C.	1	113,500	1	228,000	3	800	1	B. T.	10,000						215-lb. exhaust.
Oil							3		4,000						
Gas-Oil	2	56,000	2	99,200	2 1	990 880	2	B. T.	4,000						130-lb. exhaust.
P. C.	2	36,000	2	63,000	3	320	1	B. T.	4,000						150-lb. exhaust.
C. G. S.	1	41,000	1	80,000	2	382									
P. C.	1	32,000	1	52,000	2	340	1	B. E. T.	2,500	2	400 125				300-lb. backpressure.
Oil-Gas	2	56,000	2	99,200	2	990	2	B. T.	4,000						130-lb. backpressure.
Oil-Gas	1	17,000	1	34,000	1	350									
S.	2	44,000	2	75,000	3	450	1	B. T.	6,000						100-lb. exhaust.
P. C.	1	35,000	1	76,300											
P. C.	1	33,000	1	68,300	2	300	1	B. T.	1,500						
C. G. S.	1	30,000			2	350									
P. C.	2	25,000	1	56,000	2	300	2	B. T.	2,000						150-lb. exhaust.
							1	C. E. T.	500	2	175				Operate at 175 lb.
P. C.	2	65,000	2	200,000											
P. C.	2	65,000	2	200,000											
P. C.	1		1												200-lb. operating press.
Gas-Oil					2	700	2	B. T.	2,500						200-lb. backpressure.
P. C.	1	51,000	1	90,000			1	C. E. T.	10,000	2	7-175	9,350	2	5,300	
P. C.	1	133,000	2	198,000	1	1,750	1	C. T.	20,000			22,000	1	55,000	
P. C.	4	202,000	4	253,000	2	1,300	1	C. E. T.	3,000	1	5	Jet	1	8,250	
P. C.	1	11,800	1	25,600	1	120									
Oil-Gas	6		6				1	C. E. T.	25,000	4					
P C	1	25,000	1	42,500			1	B. E. T.	7,500	2	30 150				
P. C.	2	24,150	1	81,000											
P. C.	1	17,550	1	90,700		300									
P. C.	1	20,500	1	38,000	1	150									
Gas-Oil	2	35,000	2	59,200	2	450	1	B. T.	3,000						115-lb. exhaust.
U. S.	5	28,800	5	38,000											
Oil	3	13,500	3	72,000*	2		1	B. E. T.	7,500	2	130 35	3,600	1	4,600	* lb. per hr.
Liquor	3	16,500	3	91,000*											* lb. per hr.
	2		2												
	2		2												
P. C.	2	99,000	2	125,000	2	200	1	C. E. T.	5,000	2	5-65	7,000	1	9,000	
					1										
Oil, P. C.	1	45,000	1	90,000	3 2	300	3 2	C. E. T.	3,000 2,000	2 1	175 20	5,700 3,560	4	7,500	
U. S.					2	100									Operates at 120 lb.
							1	C. E. T.	10,000	3	100 25 4				Exhaust to brine evaporator.
					1	650	1	C. E. T.	7,500	1		8,200		14,467	
							1	C. E. T.	2,500	1	180	2,625	1	4,900	
P. C.	1	25,000			1	500									
Oil	2	35,500	2	55,600	2	300	1	B. T.	2,000						40-lb. exhaust.
Oil	2	3,000													
T. G.	2	10,000	2	36,000	1	200									
S.					1	250	1	C. E. T.	3,000	1	15				To operate as B. T.
P. C.	1	23,500			2	150						3,180			
P. C.					2	100									
Oil	1	10,500													
							1	C. E. T.	2,000	2	5 45	2,840			
S.	2	40,000													
Oil	1	34,000			1	200									Operating at 125 lb.
P. C.					2	180									
Oil-P. C.					2	90									
Wood-Oil	1	25,900	1	57,000											
C. G.	2	16,800			3	150									
P. C.	2		1	41,327	2	140	2	B. T.	750						10-lb. exhaust.
P. C.					2	240									
S. S.							1	Eng.	350						5-lb. exhaust.
Oil															
U. S.	2	45,200	1	229,000*											*I. D. Fan capacity in lb. per hr.
	1	150,000			2	50									
U. S.	1														
S.	1	21,200					1	C. E. T.	2,000	1	5	2,260	1	2,625	
Oil					8	80									12 with superheaters 5 boilers without.
S. S.	1				2	50	1	Eng.	350						
Oil	2	8,000			1	420									
P. C.							2	Eng.	400						
S.						200									
Gas					2	60									
							1	C. E. T.	1,500	2	17-80	1,280	1	3,150	
Oil							2	Eng.	150						2 diesels also.
Oil					2		1	Eng.	150						1-lb. exhaust diesel also.
							1	B. T.	1,250						25-lb. exhaust.
Wood															
Gas					1 1	112 70									
U. S.					2	200									
U. S.					2	100	1	B. T.	625						
							1	C. E. T.	1,250	1	30	1,500	1	1,800	
	1	49,300	1	103,800											Future 650 lb.— 750 deg.
							1	B. T.	1,250						18-lb. exhaust.
Gas-Oil					1	50									
T. G.	4	1,900	4	34,000	2	500									
Gas						40									
					2	60									
							1		125						
							3	Eng.	250						4.5-lb. exhaust.
S.					1	25			250						
U. S.	1	8,200			2	70									
U. S.	1	8,000													
P. C.	1	105,000			2	418									
							1	B. E. T.	1,000	1	30				10-lb. exhaust.
							1	Eng.	420						5-lb. exhaust — 300,000 cfm fandrive.
U. S.	1														
U. S.	1	28,000	1	45,000											
Oil	2	18,000			1	208									
Oil					1	80									
U. S.	2				2										

DIESEL AND GAS

Diesel production, at two million horsepower, leads durable-goods industry recovery; costs are lowered; demand greatest for small units; combination steam-diesel plants coming in; gas engines coming back

FORTY years ago, the diesel was introduced into this country for stationary-plant use — to be eclipsed by the concurrent steam turbine, for steam was already accepted. But today diesel, symbol for the ultramodern in power to the "man in the street," is coming into its own. Streamlined trains, tractors, trucks and emergency service have popularized it, and the great reduction in first cost has made it economical for power-plant use.

In the last several years, diesel production has led all the durable-goods industries. In 1935, production jumped 67% over 1934 to 1,250,000 hp. We predicted 1,750,000 hp. for this year. Present indications are that the figure is closer to 2,000,000 hp. —just 20 times diesel production in 1932!

Of course, the great percentage of this increase is in motive-power units, but even so, stationary engines account for an appreciable percentage of the total. Use of trucked-in diesels for emergency service during the spring floods and better understanding of the economies of steam-diesel operation have resulted in a number of installations. One company installing small diesels entirely in stationary plants reported an increase of 50% this year over last.

Installations are mostly small, in all kinds of industrial plants, buildings, municipals, etc., wherever steam demand is negligible.

Demand for engines of 10 to 100 hp. is greatest, due both to motive-power applications and to increasing use of dieselized auxiliaries and diesel-unit plants. The unit, combining diesel and generator or compressor, as well as radiator, filters and other auxiliaries, is coming into greater stationary-plant use because it is compact, complete and economical. Even larger engines are following the trend, more and more of them carrying all essential auxiliaries within their streamlined exteriors.

Prices are steadily being lowered due to increasing production. A 3300-hp. addition for Freeport, N. Y., cost $33.63 a horsepower, or installed, with all auxiliaries, foundation, etc., $69 a kilowatt.

Automatic control is gaining steadily—the most convenient means of avoiding a labor charge in operating the small diesel plants. This year, four or five installations of this type have been made. The Strong electrical system of control was used in Ye Eat Shoppe in New York, a 2-unit (40 kw. apiece) plant providing power, lights, refrigeration and air conditioning for a restaurant and cafe. This is the first of a series of similar plants with battery standby.

Another company has made several a.c. installations in which something other than electrical demand governs output. All thus far use two engines one turning right-hand, one left, with the generator between. In one plant, changing exhaust temperature, due to load variations, cuts the second engine in and out. In another, a 100-kw. diesel is combined with a 250-kw. steam engine. Power input of the diesels is controlled by the backpressure of the steam engine, thus balancing process-steam demand with power demand—actually controlling heat balance.

The combination steam-diesel plant is coming into its own as engineers realize its economic possibilities. The diesel takes peaks as well as weekend and summer loads when steam demand is low. The diesel acts as a readily started standby for the steam, and when the steam plant is down, boiler feedwater is kept partially heated by circulating it through the diesel jackets. Several combinations installed this year include two in New York at the Ice Club and the Empire Trust Bldg., the first having a 250-kw. diesel and a 250-kw. uniflow, the second two of each. Isolation, incidentally, is ordinary sand, as contrasted with the usual cork. A Brooklyn department store isolated its new diesels with helical springs.

The combination d.c. plant at Singer Bldg. is working out so well that in summer load is balanced between steam and diesel by controlling rheostats, the steam-unit backpressure valve being kept closed. New Yorker Hotel has added another diesel, set on an hourglass-shaped foundation so close between two building pillars that fuel pumps and governors had to be separated and the exhaust manifold carried above the engine with cylinder leads elbowed up to it.

Design Changes

Design changes are principally minor today. Most large engines are 2-cycle, most small ones 4-cycle. From 2000 to 4500 hp., there are two 2-cycle to each 4-cycle, above 4500 hp., all are 2-cycle. Almost half of the large 2-cycle engine are double-acting (there are no 4-cycle double-acting units). In single-acting units, trunk pistons have replaced the crosshead design almost entirely. With the exception of several opposed-piston designs, diesels are all vertical types.

Opposed-piston units are being announced from time to time—four companies showing them at the National Motor Boat Show. One new one transmits piston-rod motion to a crankshaft centered below through a rocker arm. Another has roller chain connecting its two shafts. One type from England has removable liners and roller bearings. The inclined-disk design based on the Michell patents, announced several years ago, was installed this year in two stationary plants, one a waterworks, the other an industrial.

For some reason, no American builder is as yet using the free-piston diesel-compressor idea now so

popular in Europe. This vibrationless, balanced and lightweight construction has real possibilities.

Incidentally, the Leipzig Fair last spring was dominated by diesels, despite Germany's difficulties in obtaining cheap diesel oil. Her efforts to overcome this economic difficulty have resulted in State endorsement of the Rupamotor, which will burn anything having B.t.u. content, from coal to peanut hulls. It shows a thermal efficiency of 32% on good anthracite, 30% on lignite, 21% on forest residues.

An interesting design at Leipzig was the diesel pile driver, the head of which is simply the diesel piston. A heavy cylinder block is hoisted in guides several feet above the piston, then allowed to drop, entrapping and compressing air. Fuel is injected through the piston, and the firing sends the cylinder block back up in the air again ready for the next stroke.

Detailed design changes are illustrated in the engines in the Review of New Equipment, page 733. One American builder has adopted the Lanova head with two side-by-side chambers, fuel being injected across the throat between them into a small precombustion chamber. Another builder has modified the common-rail injection system to avoid the delicate adjustments formerly required to equalize loading between cylinders. A metering valve, fed from an accumulator supplied by the fuel pump, delivers to each cylinder in turn through a distributor. This gives sharper opening and closing of injection, avoiding dribble, and since only one valve is used, the metered quantities are identical.

Fuel-injection pressures now run from 1,000 to 20,000 lb. per sq.in., in inverse ratio to the efficiency of the engine. The fuel problem itself remains with us, many of the light engines operating properly only on a very limited range. Demand for these ranges of light high-quality fuel is inevitably going to push up the price. This may result in a revival of the interest in heavy fuel-burning larger engines, possibly air-injection types or solid-injection units less sensitive to variation in fuel. Solid injection now is almost universal.

Most engines, except the very small ones and a few larger low-cost units, have removable cylinder liners. Nickel-chromium cast-iron is most commonly used, although some experimenting is being done with centrifugally cast and Nitraloy liners. One English builder is introducing nitrided liners (cast iron surface-hardened in nitrogen to 1000 Brinell) and obtains over 30,000 hr. from a liner, using cast-iron rings lasting about 7000 hr. Wear averages around 0.0015 in. in 8000 hr. This is in a small 1,000-r.p.m. engine. A Swiss builder uses a 2-part, sinuous-joint liner, the top glass-hard.

For additional design data, see June *Power,* pages 317-328.

Most modern German designs are convertible to gas—in case of war-time diesel-fuel shortage, but American plants have been much slower to accept this type. One new convertible operates as a diesel at a compression ratio of 14-1 and is dropped for gas-engine operation to 5-1 by a spacer between cylinder block and head. Fuel pumps, lines and injectors are replaced with an intake manifold, natural-gas mixing valve, a magneto driven off the former fuel-pump drive, and spark plugs.

Gas Engines

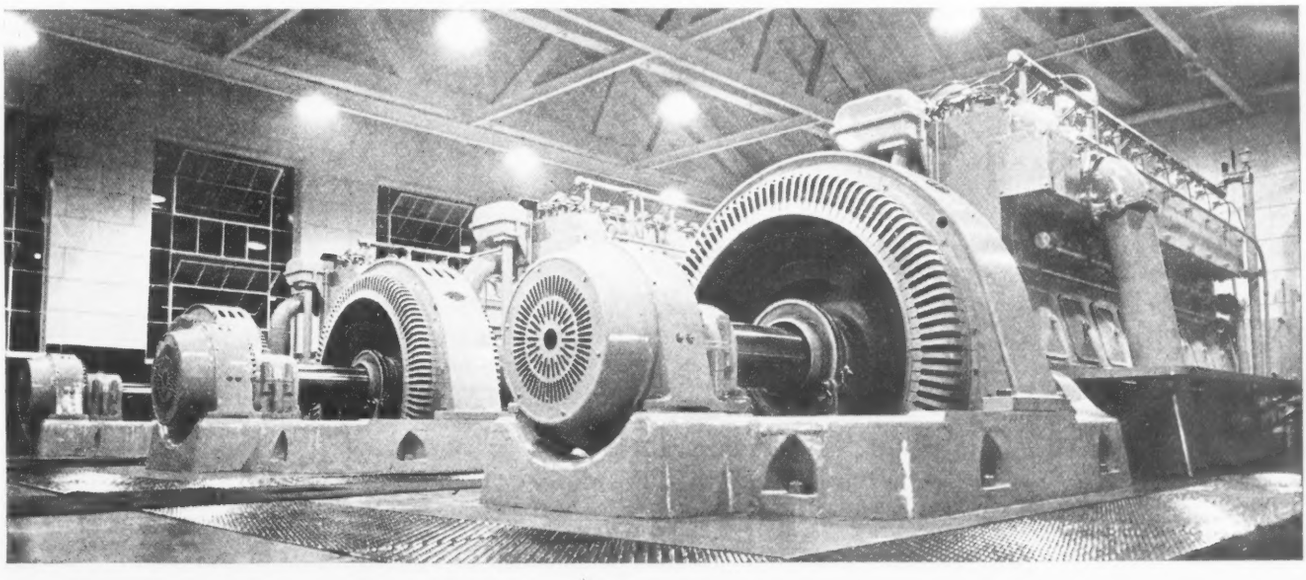
One small gas engine this year was combined with a compressor in a soundproofed cabinet, the whole unit being very compact, battery started (hence automatic) and suitable for air-conditioning.

Pittsburgh Plate Glass Co. installed an automatic gas-engine driven standby plant. A battery-operated relay permits the plant to take load within 15 sec. of a failure. Commercial parts were used.

With gas pipelines extending into new areas, economic applications on sludge-gas and further recovery from process gas, the gas engine in general seems to be regaining its popularity. There have been quite a number of sludge-gas installations recently, in which the process gas from sewage disposal provides all the light and power needed by the disposal plant at a fuel cost of practically zero.

Most modern gas engines up to 250 hp. are 2-cycle, due to timed separate injection of fuel and resulting economies. Below 400 hp. the 2-cycle is gaining ground. Economies now are about the same for both 2-cycle and 4-cycle units—12,000 B.t.u. per hp.-hr. Larger 4-cycle units drop that figure to 10,000. Battery ignition is commonest.

Gasoline engines are steadily gaining ground for emergency units, particularly in buildings and hospitals where emergency service is vital.



Three 8-cyl., 700-hp. diesels driving 2400-volt, 485-kw. alternators at Tipton, Ind.

ELECTRICITY

Public-utility plants generate 14% greater output than ever before, 3,600 r. p. m. turbo-generators three times the size of any in operation ordered; hydrogen cooling extended to large turbo-generators; Boulder Dam plant and transmission line go in

THE last twelve months will go down in history as the period when the electrical industry as well as many others actually came out of the depression. Power generation surpassed all previous records, and orders for electrical equipment were let in large volume. Beginning with the first week in January, the weekly output of public-utility generating plants equalled the peak for 1929, with 1,860,000,000 kw.-hr. and has continued a steady rise, reaching a weekly maximum of 2,196,175,000 kw.-hr. in November. Generation for the year will amount to approximately 113-billion kw.-hr., compared to 99 billion in 1935 and 97.4 billion in 1929.

Improvements in steam power-plant practice during recent years have provided utilities and manufacturers with opportunities to make large saving in power-generating costs. This, combined with the very large increase in industrial-power requirements, caused a demand for new power-generating equipment not anticipated at the beginning of the year.

Large purchases of new power-generating equipment by public utility companies was one of the features of the electrical industry in 1936. Several of these orders, representing a total of nearly 400,000 kva., were for large 3,600-r.p.m. hydrogen-cooled generators. Previous to the orders for these machines the largest 3,600 r.p.m. turbine generator in operation was 18,500 kw., an air-ventilated unit. Six hydrogen-cooled machines were ordered last year, to operate at this speed, having ratings of from 30,000 to 60,000 kva. These include a 50,000-kva. unit for Appalachian Electric Power Co., Logan, W. Va.; a 58,725-kva. unit for New York Edison Co.; a 50,000-kva. unit for West Penn Power Co., Pittsburgh, Pa.; two 60,000-kva. units for the Windsor station of Ohio Power Co. and West Penn Power Co., at Beechbottom, W. Va. A 75,000-kva. unit to be installed in the Cahokia Station, Union Electric Light & Power Co., St. Louis, Mo., is hydrogen cooled but operates at 1,800 r.p.m.

A 60,000-kva. hydrogen-cooled frequency changer for the City of Los Angeles Bureau of Power and Light establishes a new record for a machine of this type. This unit will form a tie between the city's 50- and 60-cycle power systems until all power services have been changed for 60-cycle operation. The two units of the machines are so designed that they can be separated and operated as synchronous condensers when they are no longer required as a frequency changer. Other important hydrogen-cooled units are four 60,000-kva. synchronous condensers on the Boulder-Dam, Los Angeles transmission line.

The Boulder-Dam generators and transmission line went into operation, one of the most notable engineering events of the year. Two of the large generators, each rated 82,500 kva. at 16,500 volts, 60 cycles, were put into service. Because of problems encountered in the 275-kv. transmission line running 260 mi. from the plant to Los Angeles, special features had to be incorporated in the generators that make them equivalent of 125,000-kva. units, having normal characteristics. Two generators will normally operate in parallel and will connect to a bank of three single-phase, 55,000-kva. transformers. At the receiving end, voltage will be stepped down to 132 kv. to connect to the city's transmission system through two banks of three auto-transformers.

During the past year the application of tap changing under load has been extended to include much smaller transformers than was heretofore economically possible. An installation of this kind is a 750-kva., 13,200- to 2,400-volt, 3-phase transformer with automatic-tap-changing-under-load equipment for 10% regulation in sixteen 0.6% steps. Tap-changing, under-load equipment has also been applied to transformers as small as 50 kva.

An interest development is the combination of voltage control and phase-angle control built into one unit. This was accomplished by the use of two separate tap-changing-under-load mechanisms applied to one transformer with the connection arranged so that one mechanism controlled output voltage while the other controlled output phase shift. This unit is also unique in that each mechanism has 33 operating positions, which gives phase-angle control within approximately 1.5 deg. and voltage control within about 1% on a 24,000-volt, 3-phase, 10,000-kva. circuit.

Mercury-Arc Rectifiers

Although no outstanding developments have occurred during the last twelve months in mercury-arc power rectifiers, considerable improvements have been achieved in their design and construction. More robust anode insulators have been developed, the grid construction and control has been further improved, and various accessories have been redesigned to meet more severe operating conditions.

Whereas in the past the railway field absorbed the majority of mercury-arc rectifier units, this trend has been somewhat changed. Since the beginning of 1936, orders were booked by one company from chlorine and caustic-soda manufacturers for a total of 20,000 kw. of rectifier equipment, using d.c. at 500, 600 and 1,000 volts. Many other important projects are pending. Other industrial fields which the rectifier equipment has begun to invade are steel mills and coal mining. A 1,000-kw. rectifier equipment is in course of construction for a large steel plant, and a 600-kw. 575-volt rectifier unit is on order for surface operation at a coal mine.

HYDRO

Public utility hydro-electric plants generate 41-billion kilowatt-hours, a new high; over 750,000 hp. of new hydro capacity goes into service; marked increase in small hydro plants under construction

EVEN though unprecedented floods occurred last spring on many river systems, followed by severe drought in the summer, hydro-electric plants in the United States made a new record for kilowatt-hour output. Based on figures for the first 10 mo. of the year, these plants will produce 41-billion kilowatt-hours, compared to 39.5-billion last year. Because of the large increase in output—14%—from public utility plants, water-power plants supplied only about 36.5% of the total, compared to 40% in 1935.

Severe drought during the summer caused the output of water-power plants to fall off sharply, dropping from 45% of the total output in April, the high-water month, to 31% in August, and September, when the effects of the drought reached its maximum. Falling off in waterpower plant output was made more marked by an increase of nearly 14% in public-utility plant output.

For the last three or four years the gain in new waterwheel capacity has been rather slow. According to the U. S. Geological Survey, on January 1, 1934, total installed capacity was 15,913,451 hp. On the same date 1936, 16,079,407 hp. was installed, an increase of only 166,000 hp. in two years, most of which came into service in 1934. During the last year, construction work was under way on approximately 1,750,000 hp. of waterwheel capacity, of which about 750,000 hp. went into service. Ultimate capacity under construction for which waterwheels have not been ordered represent several million horsepower. When these projects will develop into orders for hydro-electric units will depend upon how soon a market can be found for the power.

As the table on pages 714 and 715 shows, there has been a decided increase in small hydro-electric projects during the last 12 months, both in public-utility and industrial plants. This trend indicates that there are still many small water powers that can be developed or old ones redeveloped to fit economically utility- and industrial-power systems.

Improvements in waterwheels and electric generators are such that it is possible to rebuild many old hydro-electric installations and obtain a large increase in capacity at a comparatively low cost. An interesting redevelopment project is the Boulder plant of the Public Service Co. of Colorado. Two 7,000-hp. units were installed in this plant originally. These have been rebuilt for double their old rating with a large increase in efficiency, reliability and improved operation.

Because of the depression and other causes, several large hydro-electric projects that were started have been delayed. These projects are gradually reaching the initial-operation stage, and two of the more important ones went into service during the last 12 mo. One is the Diablo plant of the City of Seattle, Wash., with 166,000 hp. in two units, the other the New Kanawha Power Co., Hawks Nest plant, West Virginia, having 140,000 hp. in four units.

Of course, the most important event in the hydro field during the year was initial operation of Boulder Dam plant. Two of the 115,000-hp. units were put into service. Two more of these units will go into operation in 1937 and two in 1938. These, with the 55,000-hp. unit being installed, will give the plant an initial capacity of 745,000 hp. of a total 1,835,000 hp. planned ultimately. At present, the reservoir above the dam contains about 95 million acre-feet of water, about one-third of its normal capacity.

Tennessee Valley Authority brought Norris Dam plant into operation, with two 66,000-hp. units, the ultimate capacity of this project. This is the first development that the Authority has completed in its construction program on the Tennessee River. The first unit in Wheeler Dam plant was started near the end of the year. This plant is of the outdoor type and is designed for eight 45,000-hp. propeller wheels to operate under a 48-ft. head. Because of the large size and short length of the water passages to the turbines, making difficult accurate measurement of the large flow 8,920 sec.-ft. at full load, performance of the wheels will be accepted on the basis of tests made by the manufacturer on a model of the unit. (See page 590, November *Power*.)

Propeller Turbines

The Marmet and London plants of Kanawha Valley Power Co. went into operation, each with a 7,250-hp. Kaplan and two 6,800-hp. propeller turbines. Blade angle of one propeller turbine is adjusted automatically by the change in water flow with change of load. This is the first of this type to go into service, but a second unit rated at 9,150 hp. under 25-ft. head has been ordered for the Winfield plant of same company, on the Kanawha River, W. Va.

Construction has been continued on Bonneville plant on the Columbia River and it is scheduled to go into operation in 1937 with two 66,000-hp. Kaplan turbines, the highest powered units of their type in the world, and the largest built in the United States. The runners are 220-in. in diameter and each will have a discharge of about 12,000 sec.-ft. at 50-ft. head. These turbines are particularly interesting because they are the first large ones, the major parts of which are built with fabricated welded-plate steel. Before actual construction of these units was started in the shop, after model tests had been completed, a steel model $\frac{1}{4}$ size of the speed ring and top plate was built and stress tested to determine proper thickness of plate, location of stiffening ribs and other details of design.

Hydro-Electric Projects (Equipment Built or on

Company	Designing Engineers	Project Name	[2]New or Redevelop	River	State	Project Started	[4]Dam Type	Crest Length, Feet	Max. Height, Feet	Initial Operation	Initial Cap., Horsepower
New England States											
Connecticut Light & Pr. Co.	Connecticut Lt. & Pr. Co.	Stevenson	New	Housatonic	Conn.	1936	C. G.	546	122	1936	29,400
Penobscot Chemical Fiber Co.		Great Works	.....	.....	Me.	1936	.....	...	...	1937	.....
Central Vermont Public Service Co.			.....	.....	Vt.	1935	.....	...	...	1936	.....
Lamprey River Improvement Co.		Lamprey	.....	Lamprey	N. H.	1935	.....	...	...	1936	.....
Town of Littleton, N. H.	Howard W. Turner	Apthrop	Added	Ammonoosuc	N. H.	....	Crib	...	...	1936	.....
Connecticut Light & Pr. Co.			.....	.....	Conn.	....	.....	...	...	1936	.....
Public Service of N. H.			.....	.....	N. H.	1936	.....	...	...	1937	.....
Public Electric Light Co.	Charles T. Main, Inc.	Clark's Falls	New	Lamoille	Vt.	1936	C. G.	837	28	1937	4,500
Newport Electric Light Co.	Charles T. Main, Inc.	Plant No. 2	Redev.	Clyde	Vt.	1936	.....	...	...	1936	2,400
Sulloway Mills			.....	.....	N. H.	1936	.....	...	...	1936	.....
American Woolen Mills		Pioneer Mills	.....	.....	Me.	1936	.....	...	...	1936	.....
Middle Atlantic States											
Park Tissue Mills			.....	.....	N. Y.	1936	.....	...	...	1936	.....
West Virginia Pulp & Paper Co.			Redev.	.....	N. Y.	1936	.....	...	...	1936	.....
St. Lawrence Valley Power Corp.		Higley Falls	New	Racquette	N. Y.	1936	C. G.	210	45	1936	5,200
East North Central States											
Ford Motor Co.	Ford Motor Co. Pr.& Const. Dept.	Dundee	Redev.	Rasin	Mich.	1935	C. G.	330	12	1936	192
City of Allegan, Mich.			.....	.....	Mich.	1935	.....	...	...	1936	2,020
City of Cincinnati, O.	Burns & McDonnell Eng. Co.	Waterworks	New	Ohio	O.	1936	.....	...	...	1937	520
Wisconsin Public Service Co.		Grandfather Falls.	.....	.....	Wis.	1936	.....	...	...	1937	.....
Woodruff & Edwards Co.			.....	.....	Ill.	1936	.....	...	...	1936	.....
West North Central States											
Loup River Public Pr. Dist.	Harza Engineering Co.	Monroe	New	Loup	Neb.	1934	P. & G.	840	14	1937	9,600
Loup River Public Pr. Dist.	Harza Engineering Co.	Columbus	New	Loup	Neb.	1934	P. & G.	840	14	1937	54,000
Platte Valley Pub. Pr. & Irr. Dist.	Platte Val. Pub. Pr. & Irr. Dist.	Sutherland	New	N. Platte	Neb.	1934	R.E.F.	18,750	67	1936	35,000
Interstate Power Co.		Niobrara	New	Niobrara	Iowa	1935	.....	...	...	1936	.....
General Mills, Inc.		West A Mill	.....	.....	Minn.	1936	.....	...	...	1936	.....
South Atlantic States											
Washington Mills		Fries	.....	.....	Va.	1936	.....	...	...	1937	.....
Whitney Mfg. Co.		Spartanburg	.....	.....	S. C.	1936	.....	...	...	1937	.....
Athens Mfg. Co.			New	.....	Ga.	1936	.....	...	...	1937	.....
Clifton Mfg. Co.			New	.....	S. C.	1936	.....	...	...	1936	.....
New Kanawha Pr. Co.		Hawks Nest	New	New	W. Va.	1930	.....	...	...	1936	140,000
Kanawha Valley Pr. Co.	Kanawha Valley Pr. Co.	London	New	Kanawha	W. Va.	1934	U. S. N.	...	...	1936	20,850
Kanawha Valley Pr. Co.	Kanawha Valley Pr. Co.	Marmet	New	Kanawha	W. Va.	1934	U. S. N.	...	...	1936	20,850
Kanawha Valley Pr. Co.	Am. Gas & Electric Co.	Winfield	New	Kanawha	W. Va.	1936	U. S. N.	...	...	1938	27,550
Virginia Electric & Pr. Co.			.....	.....	Va.	1936	.....	...	...	1937	.....
Melville Woolen Company			New	Patapsco	Md.	1936	M.	326	10	1936	.....
Victor Monaghan Co.		Appalache	New	.....	S. C.	1936	.....	...	...	1937	.....
East South Atlantic											
U. S. Tenn. Valley Authority	U. S. Bureau of Reclam.	Norris	New	Clinch	Tenn.	1933	G.C.G.	1,872	266	1936	132,000
U. S. Tenn. Valley Authority	U. S. Bureau of Reclam.	Wheeler	New	Tennessee	Ala.	1933	G.C.G.	6,335	68	1936	90,000
U. S. Tenn. Valley Authority	Tenn. Valley Auth.	Pickwick	New	Tennessee	Tenn.	1935	E. F.	7,715	110	1939	110,000
West South Central States											
Central Texas Hydro-Elec. Co.		Hamilton	New	Colorado	Tex.	1931	M. A.	8,377	154	....	30,000
Red Bluff Water Pr. Con. Dist.	Vernon L. Sullivan	Red Bluff	New	.....	Tex.	1934	S. H.	9,150	104	1937	.....
Mountain States											
U. S. Bureau of Reclamation	U. S. Bur. of Reclam.	Boulder Dam	New	Colorado	Ariz. & Neb.	1931	G. A.	1,180	730	1936	515,000
U. S. Bureau of Reclamation	U. S. Bur. of Reclam.	Boulder Dam	New	Colorado	.....	....	G. A.	1,180	730	....	.....
U. S. Bureau of Reclamation	U. S. Bur. of Reclam.	Casper Alcova	New	N. Plate	Wyo.	1935	C. A.	540	261	1939	30,000
City of Idaho Falls		Lower Dam	New	.....	Idaho	1935	.....	...	...	1936	.....
City of Soda Springs		Plant No. 3	New	.....	Idaho	1936	.....	...	...	1936	.....
Showlow-Sil. Cr. Wt. Con. & Pr. Dist.	J. B. Girard	Silver Cr.	New	Silver Cr.	Ariz.	1936	C. G.	120	12	1936	125
Public Service Co. of Colorado	Pub. Ser. Co. of Colo.	Boulder Canyon	Rebuilt	Boulder Cr.	Colo.	1935	C. G.	624	177	1936	27,000
Clayton Silver Mining Co.			New	.....	Idaho	1936	.....	...	...	1936	350
Ephram City, Utah			Rebuilt	.....	Utah	1936	.....	...	...	1936	.....
Pacific Coast States											
City of Seattle	Lighting & Eng. Depts.	Diablo	New	Skagit	Wash.	1927	C.A.A.	1,260	389	1936	166,000
U. S. Government	U. S. Engineer Corps	Bonneville	New	Columbia	Wash. & Ore.	1933	C. G.	900	170	1937	137,000 House Service Unit
City of Milton			New	.....	Ore.	1935	.....	...	...	1936	.....
Rainbow Mine	C. Albert Kulmann		New	.....	Calif.	1936	.....	...	...	1936	.....
City of Spokane Water Division	Eng. Bureau, Water Div.	Upriver	Redev.	Spokane	Wash.	1935	.....	208	37	1937	5,400
U. S. Possessions											
Porto Rico Reconstruction Adm.		Carite No. 3	New	.....	Porto Rico	1936	.....	...	...	1936	.....
Porto Rico Reconstruction Adm.		Toro Negro No. 1.	New	.....	Porto Rico	1935	.....	...	...	1936	6,600
Porto Rico Reconstruction Adm.		Toro Negro No. 2.	New	.....	Porto Rico	1935	.....	...	...	1936	.....
Alaska Electric Lt. & Pr. Co.			Rebuilt	.....	Alaska	1936	.....	...	...	1936	.....
Canada					**Province**						
Ontario Hydro-Elec. Pr. Comm.	Geo. F. Hardy	Abitibi Canyon	New	Abitibi	Ont.	1930	C. G.	860	294	1933	132,000
Quesnel Lt. & Water Co., Ltd.	A. F. Peers & A. C. R. Yuill	Bakers Creek	New	Baker	B. C.	1935	R. F. C.	135	22	1936	160
Great Lakes Power Co., Ltd.	Harza Engineering Co.	Montreal River	New	Montreal	Ont.	1936	E. F.	775	32	1937	10,000
Ontario Hydro-Elec. Pr. Comm.	Ont. Hydro-El. Pr. Comm.	Ear Falls	New	English	Ont.	1936	C. G.	60	46	1937	5,000
Ontario Hydro-Elec. Pr. Comm.	Ont. Hydro-Elec. Pr. Comm.	Rat Rapids	New	Albany	Ont.	1934	R. F. C.	600	16	1935	1,200
Mattawa Elec. Lt. & Pr. Co., Ltd.			.....	.....	Ont.	1936	.....	...	...	1937	.....
Churchill River Pr. & Lt. Co., Ltd.		Island Falls	New	.....	Sask.	....	.....	...	...	1937	.....
Ontario Paper Co., Ltd.	H. G. Acres & Co., Ltd.	Outarde Falls	New	Outarde	Que.	1936	C. G.	275	50	1937	.....
MacLarin-Quebec Pr. Co.	Hardy S. Ferguson & Co.	High Falls	New	Lievre	Que.	1930	C. G.	...	...	....	90,000
Nova Scotia Power Comm.	Nova Scotia Pr. Comm.	Ruth Falls	New	East	N. S.	....	.....	...	...	....	6,290
City of Winnipeg, Man.	City of Winnipeg, Eng. Dept.	Slave Falls	New	Winnipeg	Man.	1929	.....	...	...	....	24,000
Canadian Paper Co., Ltd.		Winsor Mills	.....	.....	Que.	1935	.....	...	...	1936	.....
Foreign					**Country**						
Government of Mysore, Sivasamudram			.....	.....	India	....	.....	...	...	....	.....
Cia Minerva de Electricidade			.....	.....	Brazil	....	.....	...	...	....	.....
Explotaciones Hydroelectricas S. A.			.....	.....	Spain	....	.....	...	...	....	.....
Sao Paulo Tramway Lt. & Pr. Co., Ltd.			.....	.....	Brazil	....	.....	...	...	....	.....
Braden Copper Co.		Pangal	Rebuild	Pangal	Chile	....	.....	...	...	....	.....
Colombia Mining & Exploration Co., Ltd.			New	.....	Colombia, S. A.		.....	...	...	....	.....
Aramayo Mining Co.		Gritado	New	.....	Bolivia, S. A.		.....	...	...	....	.....
Bulolo Gold Dredging Co.		Baiune	New	.....	New Guinea	....	.....	...	...	....	.....
C. E. Halaby & Co.			New	.....	Colombia, S. A.		.....	...	...	....	.....
Caramenta Mining Co.			New	.....	Colombia, S. A.		.....	...	...	....	.....
Compania De Energia El. Del. Hula			.....	.....	Colombia, S. A.		.....	...	...	....	.....

A. C. —Allis-Chalmers Mfg. Co
M. S. —S. Morgan Smith Co.
J. L. —James Leffel & Co.
P. W. —Pelton Water Wheel Co.
I. P. M.—Baldwin Southwark Corp., I. P. Morris Div.
N. N. —Newport News Shipbuilding & Dry Dock Co.
R. H. —Rodney Hunt Machine Co.
W. —Woodward Governor Co
L. —Lombard Governor Co.

D. E.W.—Dominion Engineering Works, Ltd.
C. A. C.—Canadian Allis-Chalmers Co.
M. S. I.—S. Morgan Smith — Inglis Co.
J. M. C.—Jenckes Mfg. Co.
G. E. —General Electric Co.
W. E. —Westinghouse Elec. & Mfg. Co.
E. M. —Electric Machinery Mfg. Co.
C. W. E.—Canadian Westinghouse Co.
C. G. E.—Canadian General Electric Co

S. G. E.—Swedish General Electric Co.
O. C. —Oerlikon-Canada, Ltd.
M. P. —Mather & Platt, Ltd.
I. G. E. — International General Electric Co.
W. E. I.—Westinghouse Electric International Co.

[2] The term "New" applies to entirely new projects on sites that have not been developed previously. "Redevelop" indicates a project on a site that has been developed previously and may consist of new wheels and settings or an entirely new plant.

Order) in the United States and Canada in 1936

Added Cap., No. of Units	Date of Added Cap.	Ultimate Cap., Horsepower	No. of Units Installed	Water-wheel Capacity, Horsepower	Water-wheel Type	Speed R.p.m.	Static Head, Ft.	Design Head, Ft.	[1] Water-wheel Manuf.	[1] Governor Manuf.	[5] Draft Tube, Type	Scroll Case, Type	Penstock Valves, Type	Generator Capacity, Kva.	[3] Thrust-Bearing Location	Power Factor	Kilovolts	Cycles	[1] Generator Manuf.
1	1936	40,400	1	11,000	Francis	150	60-71	69	M. S.	M. S.	Elbow	Concrete	Head Ga.	10,000	B. G.	0.90	6.6	60	W. E.
..	....	.....	1	.....	.....	240	.....	17	J. L.	W.	.....	.....	.....	500	H. S.	....	0.125	D.C.	G. E.
..	....	.....	1	1,300	Francis	240	.....							875	H. S.	0.80	0.60	60	G. E.
..	....	.....	1	.....	.....	720	.....	.....	.....	....	.....	.....	.....	1,625	H. S.	0.80	6.9	60	G. E.
..	....	.....	1	700	Francis	257	20-28	25	R. H.	....	.....	.....	.....	.....	.....	.....	.....	.....	.....
1	1936	.....	1	420	Kaplan	251	17	17	M. S.	L.	.....	.....	.....	375	A. G.	0.80	2.4	60	G. E.
..	....	.....	1	.....	.....	150	.....	.....	.....	.....	.....	.....	.....	2,500	A. G.	0.80	2.4	60	G. E.
..	....	.....	1	2,650	Kaplan	240	.....	33	M. S.	.....	.....	.....	.....	2,250	A. G.	0.80	2.4	60	G. E.
..	....	.....	1	4,500	Kaplan	240	42	42	M. S.	M. S.	Elbow	Concrete	Head Ga.	3,750	A. G.	0.80	2.4	60	G. E.
..	....	4,800	1	2,400	.....	360	.....	.....	A. C.	W.	Elbow	.....	.....	1,875	A. G.	0.80	2.4	60	G. E.
..	....	.....	1	.....	.....	150	.....	.....	.....	....	.....	.....	.....	375	A. G.	0.80	0.55	60	W. E.
..	....	.....	1	335	Prop.	164	.....	10	A. C.	W.	.....	.....	.....	312	A. G.	0.80	0.60	60	A. C.
..	....	.....	2	675	.....	360	.....	35	J. L.	W.	.....	.....	.....	312	H. S.	0.80	0.48	60	G. E.
..	....	.....	1	893	Prop.	250	.....	23	M. S.	W.	[5] V. S.	Open Flume	.....	625	A. G.	0.80	0.48	60	G. E.
..	....	.....	1	721	Prop.	....	.....	23	M. S.	W.	[5] V. S.	Open Flume	.....	500	Direct Current		0.125	..	A. C.
1	1936	.....	1	3,040	Francis	300	.....	45	J. L.	W.	Elbow	Open Flume	.....	3,000	H. S.	0.80	2.3	60	G. E.
..	....	192	1	192	.....	138	8	8	J. L.	W.	.....	.....	.....	156	A. G.	0.80	0.21	60	G. E.
..	....	.....	1	1,320	.....	120	.....	.....	.....	W.	.....	.....	.....	1,125	A. G.	0.80	4.80	60	G. E.
..	....	.....	1	700	.....	180	.....	.....	.....	W.	.....	.....	.....	563	A. G.	0.80	4.80	60	G. E.
..	....	780	2	260	Francis	327	48	30	J. L.	W.	Elbow	.....	Gate	219	A. G.	0.80	4.15	60	W. E.
..	....	.....	1	2,000	.....	240	.....	.....	.....	....	.....	.....	.....	1,625	H. S.	1.00	2.3	60	W. E.
..	....	.....	2	100	.....	180	.....	.....	.....	W.	.....	.....	.....	94	A. C.	0.80	2.3	60	E. M.
..	....	.....	3	3,200	Francis	112.5	32-36	32	J. L.	W.	[5] E. S.	Concrete	.....	2,750	B. G.	0.95	6.9	60	W. E.
..	....	.....	3	18,000	Francis	150	109-116	112	I. P. M.	W.	[5] E. S.	Plate St.	.....	14,000	B. G.	0.95	13.8	60	A. C.
..	....	.....	2	17,500	Francis	257	206	194	A. C.	W.	.....	.....	.....	14,500	B. G.	0.90	13.8	60	G. E.
1	1936	.....	2	325	.....	225	13	13	J. L.	W.	Elbow	.....	.....	250	A. G.	0.80	2.3	60	G. E.
..	....	.....	1	1,150	.....	225	.....	47	J. L.	....	.....	.....	.....	1,000	A. G.	0.80	0.48	60	E. M.
..	....	.....	1	1,210	Francis	277	.....	36	J. L.	....	.....	.....	.....	.....	.....	....	.....	..	E. M.
..	....	.....	1	225	Francis	192	.....	20	J. L.	W.	.....	.....	.....	.....	.....	....	.....	..	G. E.
..	....	.....	1	430	Francis	180	.....	16	J. L.	....	.....	.....	.....	.....	.....	....	.....	..	W. E.
..	....	.....	1	290	Francis	225	.....	18	J. L.	....	.....	.....	.....	.....	.....	....	.....	..	W. E.
..	....	.....	2	280	Francis	200	.....	17	J. L.	W.	.....	.....	.....	250	A. G.	0.80	0.6	60	W. E.
..	....	175,000	4	35,000	Francis	150	.....	157	I. P. M.	....	.....	.....	.....	30,000	B. G.	0.85	6.9	25	W. E.
..	....	20,850	2	6,800	Prop.	90	24	23	N. N.	W.	Elbow	Concrete	Head Ga.	6,000	B. G.	0.80	4.15	60	G. E.
			1	7,250	Kaplan	90	24	23	I. P. M.	W.	Elbow	Concrete	Head Ga.	6,000	B. G.	0.80	4.15	60	G. E.
..	....	20,850	2	6,800	Prop.	90	24	23	N. N.	W.	Elbow	Concrete	Head Ga.	6,000	B. G.	0.80	4.15	60	G. E.
			1	7,250	Kaplan	90	24	23	I. P. M.	W.	Elbow	Concrete	Head Ga.	6,000	B. G.	0.80	4.15	60	G. E.
..	....	27,550	2	9,200	Kaplan	90	26	26	I. P. M.	W.	Elbow	Concrete	Head Ga.	6,150	B. G.	0.90	4.15	60	G. E.
			1	9,150	[6]A. A. P.	90	26	26	N. N.	W.	Elbow	Concrete	Head Ga.	6,150	B. G.	0.90	4.15	60	G. E.
..	....	.....	1	.....	.....	200	.....	.....	.....	....	.....	.....	.....	1,750	H.	0.70	13.2	60	G. E.
..	....	.....	1	252	Kaplan	277	14	14	M. S.	W.	[5] V. S.	Open Flume	.....	219	A. G.	0.80	0.48	60	G. E.
..	....	.....	1	1,000	.....	300	.....	40	J. L.	W.	.....	.....	.....	875	A. G.	0.80	2.4	60	A. C.
..	....	132,000	2	66,000	Francis	112.5	207-130	180	N. N.	W.	Elbow	Plate St.	.....	56,000	B. G.	0.90	13.8	60	W. E.
..	....	360,000	2	45,000	Prop.	85.7	54-43	48	I. P. M.	W.	Elbow	Concrete	.....	36,000	B. G.	0.90	13.8	60	G. E.
..	....	330,000	2	55,000	Kaplan	81.8	60-30	47	A. C.	....	Elbow	Concrete	Head Ga.	40,000	B. G.	0.90	13.8	60	.....
..	....	45,000	2	15,000	Francis	171	126	110	.....	....	Elbow	Plate St.	.....	12,500	B. G.	0.80	13.8	60	.....
..	....	.....	1	2,200	Francis	277	38-86	60	M. S.	W.	[5] V. S.	Plate St.	.....	1,650	A. G.	0.80	2.4	60	G. E.
..	....	.....	1	1,750	Francis	360	38-86	60	M. S.	W.	[5] V. S.	Plate St.	.....	1,260	A. G.	0.80	2.4	60	G. E.
			4	115,000	Francis	180	584-422	520	A. C.	W.	Elbow	Cast St.	Butterfly	82,500	A. G.	1.00	16.5	60	2 W. E. 2 G. E.
..	....	1,835,000	1	55,000	Francis	237	584-422	520	N. N.	W.	Elbow	Cast St.	Butterfly	40,000	A. G.	1.00	13.8	60	A. C.
			2	3,500	Pelton	300	584-422	520	P. W.	W.	House service units		.....	3,000	H. S.	0.80	2.4	60	E. M.
2	1935	.....	2	115,000	Francis	180	584-422	520	P. W.	W.	Elbow	Cast St.	Butterfly	82,500	A. G.	1.00	13.8	60	G. E.
..	....	45,000	2	15,000	Francis	225	221-116	195	P. W.	W.	Elbow	Plate St.	Paradox	12,000	A. G.	0.80	6.9	60	A. C.
..	....	.....	1	1,800	.....	180	21	21	J. L.	W.	.....	.....	.....	1,500	A. G.	0.80	2.3	60	G. E.
..	....	.....	1	223	Francis	720	.....	69	J. L.	....	.....	.....	.....	187	H. S.	0.80	2.4	60	G. E.
..	....	250	1	125	Francis	1200	.....	82	J. L.	W.	.....	.....	Head Ga.	100	H. S.	0.80	2.4	60	G. E.
..	....	27,000	2	13,500	Pelton	400	1,828	1,650	P. W.	P. W.	.....	.....	.....	12,500	H. S.	0.80	4.0	60	G. E.
..	....	.....	1	350	Pelton	400	.....	285	P. W.	P. W.	.....	.....	.....	.....	.....	....	.....	..	W. E.
..	....	.....	1	300	Pelton	600	.....	600	P. W.	....	Reconstruction of existing unit			.....	.....	....	.....	..	.....
..	....	332,000	2	83,000	Francis	171.5	327-247	310	M. S.	M. S.	Elbow	Cast St.	Butterfly	66,700	A. G.	0.90	13.8	60	W. E.
..	....	665,000	2	66,000	Kaplan	75	67-22	50	M. S.	W.	[5] E. H. S.	Concrete	.....	54,000	B. G.	0.80	13.8	60	G. E.
			1	5,000	Kaplan	257	67-22	50	M. S.	W.	Elbow	Plate St.	.....	3,200	A. G.	0.80	2.4	60	E. M.
..	....	.....	1	500	Francis	600	70	70	J. L.	....	.....	.....	.....	.....	.....	.....	.....	.....	.....
..	....	.....	1	150	Pelton	600	.....	295	P. W.	....	.....	.....	.....	125	H. S.	0.80	2.4	60	G. E.
..	....	.....	3	1,800	Kaplan	200	34	33	A. C.	A. C.	Elbow	Concrete	.....	1,625	A. G.	0.80	2.3	60	A. C.
..	....	.....	1	900	Francis	720	.....	210	J. L.	W.	.....	.....	.....	800	H. S.	0.80	2.3	60	W. E.
..	....	10,500	1	6,600	Impulse	600	.....	1,580	M. S.	W.	.....	.....	.....	5,400	H. S.	0.80	2.3	60	E. M.
..	....	.....	1	2,700	Impulse	300	.....	630	M. S.	W.	.....	.....	.....	2,400	H. S.	0.80	2.3	60	W. E.
..	....	.....	2	600	Pelton	360	.....	190	P. W.	....	Reconstruction of existing units			.....	.....	.....	.....	.....	.....
2	1936	330,000	5	66,000	Francis	150	246-223	237	C. A. C.	C.A.C.	Elbow	Plate St.	Head Ga.	48,500	A. G.	0.85	13.8	25	C. G. E.
..	....	400	1	160	Francis	220	24	24	J. M. C.	W.	Conical	Open Flume	.....	120	.....	0.80	2.3	60	C.W. E.
..	....	25,000	1	10,000	Francis	277	190	186	M. S. I.	W.	Elbow	Plate St.	.....	10,000	B. G.	0.90	11	60	C. G. E.
..	....	25,000	1	5,000	Propeller	180	44-26	36	M. S. I.	W.	[5] V. S.	Concrete	.....	4,500	A. G.	0.85	6.6	60	O. C.
1	1936	2,850	1	1,650	Prop.	128.5	18-12	16	D. E.W	W.	[5] V. S.	Open Flume	[7] S. L.	1,500	A. G.	0.85	2.3	60	C. G. E.
..	....	.....	1	830	Kaplan	257	.....	22	M. S. I.	....	[5] V. S.	Pressure Flume	.....	.....	.....	.....	.....	..	S. G. E.
1	1936	.....	1	19,000	Prop.	150	56	56	D. E.W.	W.	.....	.....	.....	18,000	A. G.	0.90	6.6	60	C. G. E.
..	....	.....	2	35,300	Francis	180	231-222	208	C. A. C.	W.	Elbow	Plate St.	Butterfly	26,315	A. G.	0.95	6.6	60	C. G. E.
1	1936	120,000	4	30,000	Francis	180	.....	.....	C. A. C.	W.	Elbow	Plate St.	.....	25,000	A. G.	0.85	13.2	60	C.W. E.
1	1936	10,590	1	4,300	Francis	360	111-106	104	D. E.W.	W.	St. Conical	Plate St.	Butterfly	3,300	A. G.	0.90	6.6	60	M. P.
1	1936	96,000	3	12,000	Prop.	94.7	33-22	30	D. E.W.	W.	Moody	Concrete	Head Ga.	10,000	A. G.	1.00	6.6	60	S. G. E.
..	....	.....	2	1,100	[6]P.M.A.	180	.....	19	D. E.W.	W.	.....	Concrete	.....	1,000	.....	....	.....	..	C. G. E.
1	1936	.....	.	.....	.....	375	.....	.....	.....	....	.....	.....	.....	7,060	H. S.	0.80	2.2	25	I. G. E.
1	1936	.....	.	.....	.....	400	.....	.....	.....	....	.....	.....	.....	1,700	H. S.	0.80	6.6	60	I. G. E.
1	1936	.....	.	.....	.....	300	.....	.....	.....	....	.....	.....	.....	1,933	.....	0.75	6.0	50	I. G. E.
1	1936	.....	.	.....	.....	360	.....	.....	.....	....	.....	.....	.....	55,000	H. S.	0.85	11.0	60	I. G. E.
1	1936	.....	1	8,700	Pelton	360	.....	1,475	P. W.	....	Reconstruction of existing unit			.....	.....	.....	.....	.....	.....
1	1936	.....	1	1,200	Pelton	450	.....	350	P. W.	....	.....	.....	.....	1,000	H. S.	0.80	4.4	60	I. G. E.
1	1937	.....	1	315	Pelton	720	.....	525	P. W.	W.	.....	.....	.....	.....	.....	.....	.....	..	I. G. E.
1	1936	.....	5	1,000	Pelton	600	.....	500	P. W.	W.	.....	.....	.....	875	H. S.	0.80	11.5	50	I. G. E.
..	....	.....	1	140	Francis	900	.....	61	I. P. M.	....	.....	.....	.....	.....	.....	.....	.....	..	W. E. I.
1	1936	.....	1	2,500	Impulse	327	.....	280	M. S.	W.	.....	.....	.....	2,000	H. S.	0.80	2.3	60	W. E. I.
1	1936	.....	1	250	Francis	900	.....	87	I. P. M.	W.	.....	.....	.....	.....	.....	....	.....	..	I. G. E.

[3] A. G. indicates that the thrust bearing is above the generators rotor; B. G., thrust bearing located below the rotor; H. S., horizontal-shaft design.

[4] G. C. G., gravity type with control gates; M., masonry; E. F., earth fill; S. H., semi-hydraulic; P. & G., piers and gates; R. E. F., rolled earth fill; C. G., concrete gravity; M. A., multiple arch; G. A., gravity arch; C. A. A., constant-angle arch; C. A., concrete arch; U. S. N., United States navigation; R. F. C., rock-filled timber crib.

[5] E. S., elbow with splitter plate; E. H. S., elbow with horizontal splitter plate; V. S., vertical steel.

[6] P. M. A., propeller type with manually adjusted blades; A. A. P., propeller type with automatically adjusted blades.

[7] S. L., Stop logs.

Left—V. M. Frost, mech. engr., of N. J. Public Service Co.; John Faye, chief engr., Middletown State Hospital; B. C. Heacock, president, Caterpillar Tractor Co.; W. L. Lyle, president, Carrier Corp.

POWER

Panorama of 1936

IN A SETTING that reflected the return of prosperity and business confidence, equipment meeting requirements of high-pressure and high-temperature steam plants was very much in evidence at the Twelfth National Exposition of Power & Mechanical Engineering. Even though the show, with nearly 300 exhibitors, was not as large as some earlier ones, it displayed good showmanship that would have been the envy of P. T. Barnum.

The best part of all the sparkle and brilliance that dominated the show was that the exhibits lost none of their practical value of former years. If anything, the show offered greater educational opportunities than ever before.

The exhibition was a measure of up-to-date developments in power generation and application, as exemplified by large steam-generating units for high-pressures and temperatures; high-tensile strength, corrosion and wear-resisting alloys; valves, expansion-joints and other fittings for high-pressures and temperatures; refractories and heat insulation for a wide variety of services; welded constructions; meters and automatic combustion control; power-generating and converting equipment; mechanical power-transmission equipment, lubricants and lubricating equipment; all to meet the ever-increasing demands of industry.

During the two years since the last Power Show, air conditioning and methods of dust prevention have made tremendous progress, and this was evidenced in the show by the several exhibits. An exhibitor of turbo-compressors and industrial cleaning machines featured the prevention of dust hazards in factories and foundries. New industrial vacuum cleaners were offered as a preventative of silicosis caused by dust in the lungs of workers. A variety of new attachments to solve many difficult cleaning problems by vacuum-cleaning equipment was exhibited. Air-conditioning equipments for heating in winter and cooling in summer were displayed by several manufacturers. The old problem of cinders from power-plant stacks was not overlooked, and several designs of equipment for eliminating this nuisance were demonstrated.

Boilers

Three large boiler manufacturers were in the show this year. One demonstrated a new steam scrubber that is installed in the boiler drum. A working model of a steam drum 42 in. in diameter was demonstrated with compressed air and water in just the same way that it would operate when producing 27,000 lb. of steam per hour at 450 lb. pressure. Feed water is sprayed through nozzles to provide a continuous curtain of water through which the steam must pass. Solids are washed from the steam, and as it passes through the scrubber it is relieved of its moisture, so clean dry steam is delivered to the superheater. This exhibit also included a coal pulverizer with a capacity of 3,100 lb. per hr. in operation, and with a cutaway section, so that the action of all grinding parts could be observed.

Another manufacturer exhibited an unusually interesting collection of cross-sectional drawings of boilers arranged in four groups, namely, for capacities of 1,000 lb. to 50,000 lb.; 50,000 to 200,000 lb.; 200,000 to 500,000 lb.; and 500,000 lb. to 1,000,000 lb. of steam per hr., and for pressures up to 1,500 lb. and 1,000 deg. temperature.

To provide a high-temperature heating medium at low pressure, another boiler manufacturer exhibited a boiler in which a fluid, comprising a mixture of about 73% diphenyloxide and 27% diphenyl, is used. This liquid is fluid at 54 deg. F., has a boiling temperature of 500 deg. at atmospheric pressure, and the vapor has a temperature of 750 deg. at 135 lb. gage. The material is non-corrosive, non-poisonous, and the operation of the system is as simple as that of the ordinary boiler.

Valves

High temperatures and high pressures were very much in evidence among the valve exhibits. One exhibit included a 1,500-lb., 925-deg., 10-in. gate valve. In another exhibit there was shown a 12-in. angle boiler stop and check valve rated at 650 lb. and 850 deg. This valve had been subjected to a hydrostatic test of 2,000 lb. per sq. in. A 10-in., alloy-steel, non-return valve built for 1,250 lb. and 900 deg. F. was part of another exhibit. This valve was hand-operated and arranged so that the 18 anti-friction bearings of its operating mechanism could be force-lubricated with a grease gun. Blowoff valves, safety valves, water columns, reducing valves, gage glasses and other boiler auxiliaries for pressures up to 1,500 lb. were part of the exhibits in other booths. In addition to the high-pressure equipment, several large valves for lower pressures were demonstrated.

Welding

High pressures and high temperatures have given a new significance to welding methods, and this was evidenced in several welding and boiler-equipment manufacturers exhibits, that showed samples of how dependable modern welding processes are. One company depicted the value of oxy-acetylene welding and cutting in fabrication, installation and maintenance of power-plant equipment. The last year has been marked by outstanding process and apparatus developments in the welding and cutting of metal, and those which apply particularly to the power field were featured. Welding of power piping by both the multi-flame and single-flame welding methods was displayed. The latest technique for welding stainless steel was shown, along with the recommended method of bronze-welding cast-iron pipe.

An interesting demonstration, and one which drew a great deal of attention, was the testing of welded specimens in an

Left—C. W. Dibble at the Power booth; looking 'em over at the Crane booth; steam scrubber at the B & W booth; the Bridgeport Brass cowpuncher

SHOW

Pattern of 1937

Oxwelded portable tensile-strength-testing machine. Apparatus displayed included several of the latest automatic flame-cutting machines, new acetylene generators, and oxygen and acetylene regulators. Cutting equipment was shown that would cut the welding bevel on the end of a pipe almost as smoothly as it could be machined. A multiple-flame welding torch comprised three tips, one to preheat the metal, another to melt the rod and pipe, and a third to anneal the weld, so that the complete process of welding can be completed in one operation. It was demonstrated that with new forms of copper and brass fittings any experienced plumber or steam fitter can easily install brass and copper pipe of any size and make brazed joints with threadless fittings good for 150 and 250-lb. steam pressure.

A new electric welder operated on alternating current and supplies direct current through electronic tubes. It is intended for the fabrication and repair of light steel parts, is compact, easy to operate, and will permit operators to weld with electrodes from 1/16 in. to 5/32 in. in diameter with a current range at from 18 to 90 amp.

An example of how good a weld can be made was featured in a large valve-manufacturer's booth. The sample comprised a 1.75-in. bar of carbon steel with a weld in the middle, taken from a pipe. This bar was given a free-bend test, and bent until the two pieces of parent metal each side of the weld almost came together, causing 108% elongation in the outer fibers of the weld, without showing serious signs of failure.

Meters and Control

Automatic combustion control and meters were represented by several very interesting exhibits. All demonstrated full-size units for the control of a single boiler or a bank of boilers, and complete metering equipment. How sensitive a modern automatic-combustion-control regulator may be was featured at one booth. A platform was attached to one of the company's standard regulators on which a man could stand. By blowing lightly into a small rubber funnel about 1 in. in diameter at the mouth, at a distance of about 12 or 18 in., the demonstrator would be lifted immediately as the regulator responded. Another control manufacturer featured a cross-sectional drawing of several modern boiler installations to which automatic combustion control had been applied, which showed the various conditions that modern control equipment must meet. Among several other features of another meter and control manufacturer's exhibit was an illuminated cross-section of a power plant indicating what could be done in applying meters and control equipment from the fuel in the boiler plant all the way out to the transmission line. Meters for doing a good many of these things were exhibited and demonstrated. A new type of flow meter operated on a new principle using a mercury U-tube supported on a weigh beam, was shown. When there is no pressure differential, mercury level is the same in both legs of the tube and the beam is balanced. Changes in flow throw the beam out of balance and cause a motor-driven governor to load the beam and rebalance it. Governor speed is a function of flow, and, therefore, to integrate the flow all that is necessary is to use a counter to record its revolutions. A small generator driven by the governor supplies the potential to an indicating and recording meter that can be located at any distance from the metering device. Since governor speed is a function of flow, the potential of the generator is also a function of flow, and, therefore, the indicating and recording device becomes a simple electrical meter.

In the indicating and recording meter field, the tendency is definitely toward multiple indicators and recorders. Multiple indicators can be had with almost any desired number of instruments in one bank. A recorder was demonstrated that would give 16 graphs on one chart. Featured at one booth was a portable Orsat-type gas analyzer built to meet the needs of boiler-room operators and combustion engineers. In this device, the fundamental accuracy and simplicity of the Orsat principle of volumetric measurement and chemical absorption is retained, but an ingenious automatic mechanism replaces the varying human element, filling the modern need for simpler, speedier gas analyzing. This makes it possible for anyone to analyze a gas sample by one simple movement of a rod, with results immediately indicated by a pointer on a large legible scale.

Another interesting metering system makes it possible continuously to weigh material traveling on a conveyor and to transmit the weight any distance from the scale. A platform is attached to the scale over which a section of the belt carrying the material travels. Movement of the scale is transmitted through a sender element of a telemetering system which transmits it to a receiving member that can be located anywhere and which will indicate, record and integrate the weight.

A new flow controller was demonstrated for automatically maintaining the flow of liquid, vapor or gas in piping systems at any desired fixed rate. It consists of a standard Rotameter with a magnetic armature rod attached to the float of the metering tube, a divided transmitter coil attached to the Rotameter. The control unit itself contains a divided receiving induction coil, grid-controlled electronic tubes, driving motor energized by the tubes, and the flow-control valve located in the same line as the flowmeter and driven by the motor.

A new combustion-safeguard system known as the Protectoglo, which eliminates the hazard of filling a furnace or oven with an explosive mixture, was demonstrated. It is particularly applicable to

gas-fired installations to close the main gas valve automatically, if the flame fails even momentarily. The system may be arranged to signal in addition to automatically shutting off the main gas supply. It may also be arranged to automatically start the electrical ignition at the pilot and maintain this ignition for a short time and, if the flame does not return, shut off the pilot supply and the ignition.

Coal Handling

Handling of coal, stone and other solid materials in a rubber hose is something that probably has not occurred to most engineers, but it an accomplished fact, as was shown by one exhibit. Each half of the hose is made endless and has a chain running through it to transmit the load; both halves running over pulleys, and the two interlock together as indicated by the figure. One half of the tube runs under the loading hopper and receives the load, and as it comes out the other half comes down around over a pulley and is interlocked to it. As the loaded tube travels it is twisted much in the manner of a rope so that the halves are pressed together, causing a tight seal and preventing the tube from opening. The material can be carried in any direction, and when it reaches the receiving hopper the hose straightens out and the top half is lifted off, while the botom half continues over another pulley and drops its load.

Diesel Engines

The diesel engine was represented by three companies. One of these showed its new "streamlined" crankless opposed-piston unit developing 150 hp. at 1,200 r.p.m. It has a cover and exterior designed by Count Alexis de Sakhnofsky, noted stylist, first instance we know of, or artistic styling applied to a power plant. Design in general is similar to the first unit showed two years ago, although a number of small modifications have been made. Piston rods are now ball-and-socket jointed at both ends to reduce binding and side thrust and other refinements have been made to make the engine as accessible as possible. A piston can now be taken out in 15 min. Another company showed several engines, the largest an 88-hp. unit. Engine No. 21,000 was also on display—indicating that this builder, now largest in the world, is averaging a production of almost 1,000 engines a month, including a new V-type 160-hp. planned particularly for stationary service. A third company showed two sizes of its engines. This company, a large producer of automotive units, has made many stationary installations, however, in flour and feed mills, sawmils, etc.

Electrical Equipment

Electric power exhibits were not as numerous as in former years, but the use of electricity in metering, control and other operations was very much in evidence in a great many exhibits. The outstanding piece of electric-power equipment in the show was a metal-tank, 300-kw., 500-volt, mercury-arc rectifier with electrically energized grids for voltage control. This rectifier was in operation supplying power to a motor-generator set

Leeds & Northrup (top) and Sterling Engine booths, and (below) section of Johns conveyor belt

which was tied back into the alternating-current power system and arranged so that the control of voltage and power flow could be demonstrated.

With a grid-control rectifier the direct-current output voltage can be regulated, even though the alternating-current anode voltage remains constant. Regulation is accomplished by controlling the electrical potential applied to a grid located just below each anode so as to delay the relative instant at which each anode is permitted to ignite. The control of the rectifier is therefore not continuous, but is rather intermittent. During each cycle of alternating-current supply, the voltage impressed on the direct-current line is too high during part of the cycle and too low during another part of the cycle, so as to average, at the desired value, somewhat on the same principle as the voltage of a generator is alternately too high and too low by a vibrating regulator to obtain an average voltage of correct value.

This method of grid control permits the utilization of rectifiers, not only for rectifying alternating-current, but also for the inversion of direct current to alternating current, for frequency conversion, and for direct-current power transmission.

Permanent magnets are generally looked upon as something out of place for holding in heavy alternating-current contactors, but this is now an accomplished fact and a heavy three-pole contactor of this type was demonstrated. Alternating-current contactors of this type are similar in construction to standard ones, but have silver contact tips, a permanent-magnet core in the coil, made of an alloy known as Alnico, a copper-oxide rectifier, and the necessary electrical interlock. The contactor is closed by pressing a momentary-contact pushbutton to energize the coil through the rectifier. As soon as the contactor pulls in and locks the interlock on it breaks the circuit and the permanent-magnet core of the coil is now energized to sufficient strength to hold the contactor closed. Hence the magnet is held closed without any power on the coil. To open the contactor the stop button is pressed to energize the coil through the rectifier in the opposite direction, thus demagnetizing the permanent-magnet core and allowing the contactor to drop open.

Power Transmission

The wide variety of mechanical power-transmission equipment for all manners of application emphasized the importance of the connection between the power source and its load. These devices included flat belts, pulleys, shafting, anti-friction bearings, multiple V-belts for open, quarter-turn, reverse and multiple shaft drives; silent and roller-chain drives, clutches, gears for almost any speed change and for most any drive position; and geared motors combining a high-speed motor and a reduction gear in a single compact unit.

Variable-speed transmissions were represented in five companies' products. These have been developed for a very high degree of precision of speed control, and combine a variable-speed drive and motor into a unit as compact as a gear motor. One manufacturer demonstrated the application of one type of these units to a machine for winding a web off one roll onto another. This unit could wind in either direction at constant web speed and tension, irrespective of the change in roll diameter as the winding proceeded.

In recent years, a new system of group drive has been developed and found favor for many applications under the name "Modern Group Drive." This system was demonstrated by the Power Transmission Council in its exhibit. Although belts form an important part of this system, other equipment, such as chains, gears and V-belts and combinations of them are also used.

This system differs from the old in many respects. It is intended for comparatively small groups of small and medium-powered machines. Comparatively short, light, high-speed shafting operates in anti-friction bearings, supported in improved hangers on a system of steel channels attached to the buildings. This steel work not only provides a good support for the shafting, but it also permits bearings to be located at load points along the shafting, insuring minimum shaft distortion. The shaft can also be kept in line conveniently and the anti-friction bearings insure high operating efficiency.

New Boiler and Operation Discussed at

POWER SESSIONS

A new Steamotive unit boiler described, operation at Port Washington reported, cinder catchers described and results of condenser tests presented

Annual Meeting
Nov. 30-Dec. 5

Steamotive

For the past two years it has been rumored that General Electric and Babcock & Wilcox were developing a unit power plant of about 1,000 hp. this development work was shrouded with great secrecy, but the veil has now been lifted to reveal the new "Steamotive" unit. It was described by E. G. Bailey, A. R. Smith and P. S. Dickey.

The developmental Steamotive unit is oil-fired, designed for an output of 21,000 lb. of steam per hr. at a pressure of 1,500 lb., and 900 deg. leaving the superheater.

No serious defects were encountered in any of this equipment. During tests the complete unit operated 950 hr., much of which time was at continuous maximum rating with long periods under extremely variable load conditions. Combustion rates exceeded 400,000 B.t.u. per cu. ft. per hr. at peak, and 375,000 under continuous load. The unit operated over an output range of 10 to 1 under complete automatic control.

The flame and gas pass horizontally through the completely watercooled furnace which is approximately 3½ ft. wide, 3½ ft. high, and 7½ ft. long from the burner wall to the boiler-screen tubes. The gas then passes up and back with a 180-deg. turn into the superheater, flowing around a separator to the economizer, air heater and up to the stack. Air for combustion leaves the blower at about 60 in. water pressure, passing to flues intersecting the stack and down around the air-heater tubes to the oil burner. There is no induced-draft fan.

Feedwater enters the economizer inlet header, from which it flows through 29 horizontal coils to the outlet header. From the outlet header the flow is divided into five circuits, all five of which form the floor, side and roof of the furnace as well as two sets of loops forming a boiler screen. All steam is generated in these five furnace and boiler circuits and enters a separator with a surplus of about 400 lb. of water per hour in each circuit. From the separator the dry steam goes through the superheater and directly to the main turbine. Water from the separator is called "spill-over" and passes through a heat exchanger to the hotwell, where it mixes with condensate and is refed to the boiler.

The superheater occupies only about one-third of the available space. Roof, rear wall and side walls of the cavity in the rear of the superheater are lined with closely spaced superheater tubes forming a radiant section, the purpose being primarily to protect the inner casing plates from excessive gas temperature. Superheater tubes are KA2S alloy steel (18% chromium, 8% nickel), supported by alloy-steel rods hung from roof with springs to take care of expansion.

The air heater is made up of 1,515 tubes 2 ft. 4 in. long. The tube ends are welded into steel tube sheets. Gas flows inside the tubes and air flows outside.

Inlet connections from the five furnace circuits enter the separating drum tangentially, with the ends of the tubes flattened. The two steam-outlet connections are 180 deg. apart, with their centerline 18¾ in. above the centerline of the inlet connection.

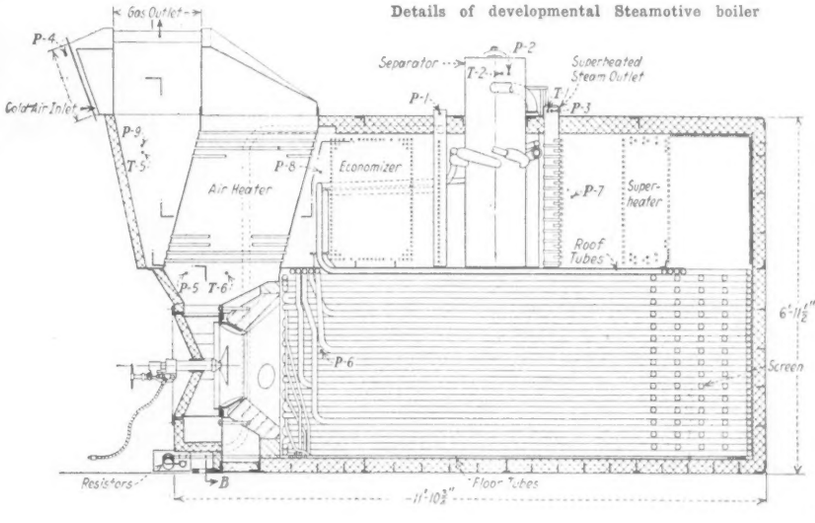
To save space and complexity of control and improve efficiency, all boiler auxiliaries are driven by a single, relatively high-speed turbine. Auxiliaries which it drives consist of a reciprocating feed pump, a blower for furnace combustion air, and a positive oil pump of the positive displacement type. The entire set runs at a speed determined by the steam output of the boiler, with modifications to blower output by means of dampers, and to fuel-oil output by means of a bypass on the fuel-oil pump.

The combustion-air blower is a centrifugal compressor having a maximum discharge head of about 60 in. of water. The boiler-feed pump is a single-acting 5-cyl. piston pump running at a normal speed of about 800 r.p.m. with pressure lubrication of the crankshaft pins, connecting rods and crosshead wrist pins.

In view of the limited amount of water and heat storage in the Steamotive, and since all natural circulation is eliminated, it is of utmost importance in operating this unit that water be fed as nearly possible equal to the rate of steam output plus "spillover." The desired rate of water flow is established by measured indications of total boiler steam flow and separator drum level. Spillover water delivered into the separating drum is maintained constant at all outputs.

The auxiliary set is designed to provide an excess of air and oil at any given feed-pump speed, and the automatic-control equipment is arranged so that the necessary throttling of both is provided to maintain a constant steam pressure at the boiler output. In addition, the ratio of fuel and air is closely controlled in accordance with metered indications of each, to maintain minimum allowable excess air required for good combustion.

The oil burner is provided with a propane torch with dual spark ignition and with a photo-electric flame indicator. A 3-way valve which shuts off automatically oil to the burner and recirculates the oil to the suction side of the pump, a solenoid valve in the propane line to the torch, and the spark igniters for the torch are interlocked to perform the following functions: (1) Upon closure of the lighting switch the igniters are energized and the propane valve opened, lighting the torch. After a short delay



Details of developmental Steamotive boiler

the fuel oil control valve is opened to the burner, and as soon as ignition of the oil fire is established, as indicated by the photo-electric flame detector, the propane torch and igniters are cut off after a short-time delay. (2) Fuel oil is shut off in case of high boiler pressure, high superheat temperature, high temperature at outlet of any furnace circuit, and flame failure. (3) The oil burner is automatically relighted when boiler pressure is restored, superheat temperature restored, or high temperature in any of the furnace circuits is restored to normal. (4) Upon loss of flame, the relighting cycle is repeated several times, and if flame cannot be established, the unit is shut down, requiring manual reset. (5) Upon loss of feed-pump suction pressure or loss of auxiliary set lubricating oil pressure, the oil fire and torch are shut off and the air supplied to the governor of the auxiliary-set turbine is likewise cut off, shutting down the auxiliary set.

Although the designed capacity for continuous running was for 16,000 lb. of steam per hr., the unit ran 40 continuous hours at 21,000 lb., and was tested up to 22,000 lb. per hr., which was the limit of the blower for continuous operation. Steam temperature leaving the superheater at an output of 16,000 lb. per hr. is 870 deg., rising to 910 deg. at 22,000 lb. per hr., and dropping to 770 at 5,000 lb. per hr. Air enters the burner at 450 deg. at a rating of 16,000 lb. per hr., and 500 deg. at 22,000 lb. per hr. Boiler efficiency varied from 75%, based on the high heat value, at a rate of 22,000 lb. per hr., up to 85.5% at a rate of 5,000 lb. per hr. Efficiencies were 4 to 5% higher than those originally anticipated.

Starting from cold, the boiler steamed at reduced pressure within 4 min. and picked up to full load with normal pressure and temperature after 6 min. more.

Discussion

Dean Potter of Purdue was first to congratulate B. & W., G. E. and Bailey Meter on their cooperative accomplishment. Experiments at Purdue, he said, convinced him that the automatic control will be successful. He wondered why the steam temperature was not carried above 850 deg. and what was done about water treatment. Steamotive, he felt, may have a real future for railway motive power and for space-limited stationary applications.

Several questions were raised by Prof. Christie of Johns Hopkins. How will the control system stand rough riding on the rails? Does scale form on the tubes? If so, how can it be removed? Do the high temperatures threaten sagging of superheater roof coils?

The future of Steamotive for locomotive applications was questioned by E. S. Dennison. Will not a unit working so close to today's limit of compactness, pressure, temperature and control be "touchy"? Has a true economic balance been struck among boiler efficiency, auxiliary power, condenser pressure, etc. (remembering, for example, that a little loss of vacuum will offset a lot of boiler efficiency)? Might not lower steam pressure and temperature be better economics? How much power do auxiliaries take? Why squeeze the steam unit to make space for a costly and energy consuming electric drive when a geared-turbine drive gives full traction and better efficiency at lower first cost?

Comparing Steamotive unfavorably with diesel, Mr. Dennison said that diesel oil, delivered, costs only 30% more than "Bunker C" and that actual fuel operating cost of Steamotive will be 93% higher than for a diesel. He admitted that coal fuel may change this picture.

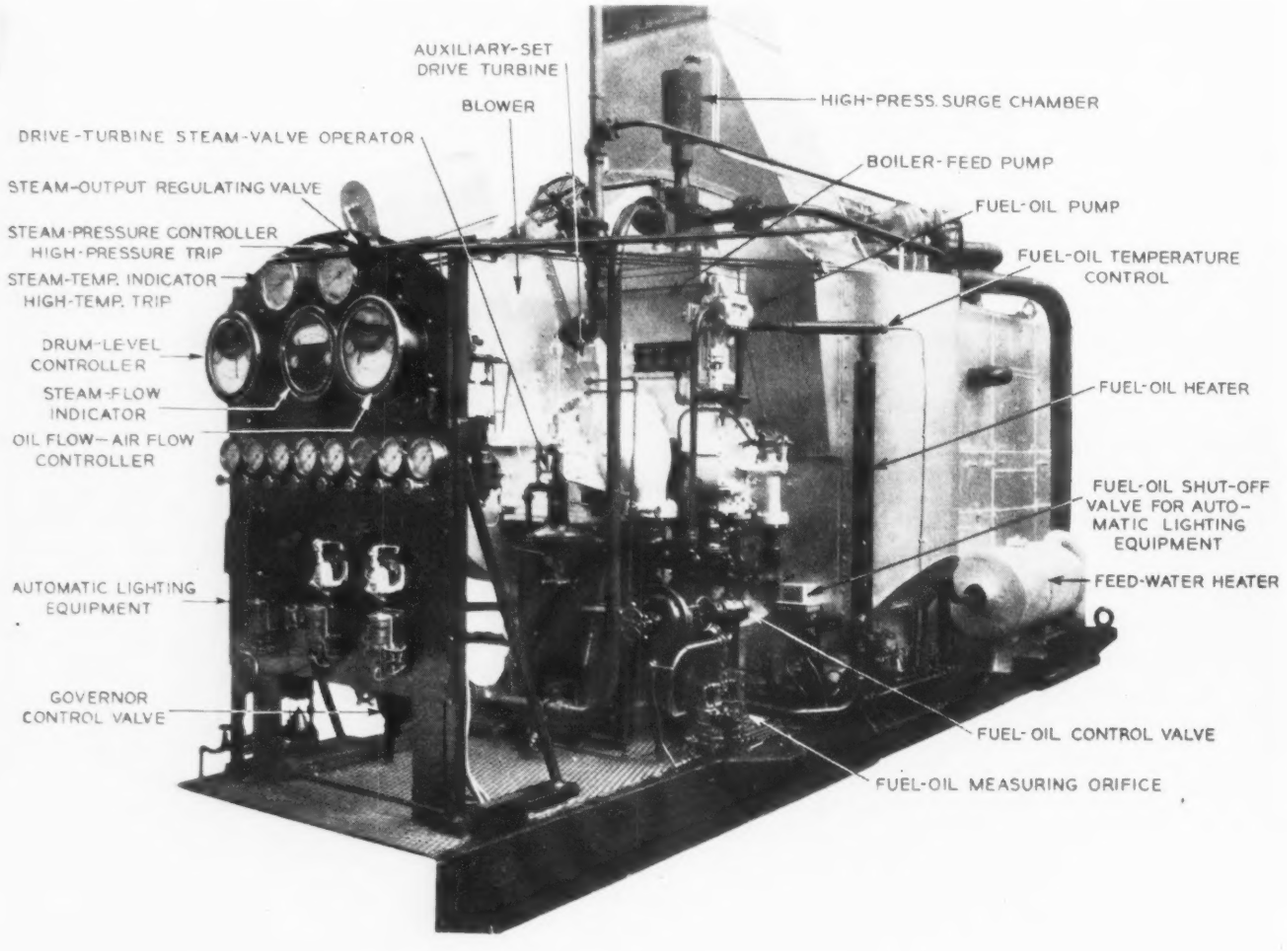
I. E. Moultrop, took the opposite stand, referred to Steamotive as an epoch-making advance whose incidental problems will surely be solved. Experiences at Edgar station had taught him that dire predictions often fail to materialize.

That Steamotive and similar units will have a real future for marine drive was predicted by W. W. Smith. He complimented the designers on a successful 800-r.p.m. reciprocating feed pump.

Several speakers had asked about scaling of the coils. All were therefore interested in the statement of N. C. Artsay that he had operated a straight-tube boiler for two years on sea water. The water (plus a little oil) was sprayed. High velocity carried solids through without deposit.

In his closure, A. R. Smith of G.E. said it is not planned to run Steamotive on raw water. Only condensate and distilled makeup will be used. Operating troubles may be expected at the start, but they will be overcome. The heat liberation of 400,000 B.t.u. per cu.ft. is not high. Some day we should easily reach 1,000,000, he predicted. Within two months a unit

The "Steamotive", combined boiler and turbine unit



fired by pulverized coal will start up.

He suggested that the utilities could use Steamotive units to supply steam to industrial plants and sell them their electricity from the transmission lines.

Experiences at Port Washington

SELDOM do power engineers have the opportunity to hear a paper that frankly discusses the operating troubles encountered in starting a new plant. Hence F. L. Dornbrook, describing operating experiences at Port Washington, Wis., created great interest.

Port Washington is characterized by unit design, and contains an 80,000-kw. turbine supplied with steam at a pressure of 1,230 lb. and 825 deg. temperature from a single 690,000-lb. per hr. bent-tube boiler.

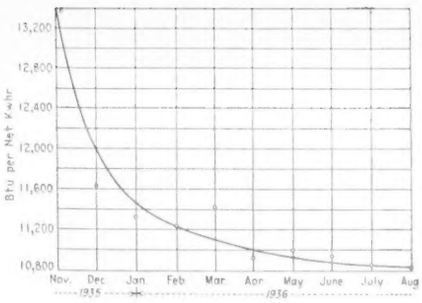
The turbine was first cut in on load on Oct. 14, 1935, when 6,000 kw. was carried, but was shut down after an hour's operation because the governor functioned improperly. Oct. 17 and 18 the unit operated with a load of 22,000 kw. during two runs of 11 and 18 hours. CO_2 in the furnace had to be held at 9% to limit reheat temperature to 825 deg.

Operation was continued for 4 days more, each of 24 hours' duration, with the load varying between 26,000 and 28,000 kw. CO_2 again had to be limited, this time to 6% to prevent reheat temperature from exceeding 825 deg. On Oct. 25, operation was such that for the first time there was no foaming of the boiler water. Over the following week-end the pulverized-coal burners, which are of the vertical fan-tail type, were changed by reducing the tip area 50% to throw the flames further down into the furnace. On Oct., 31, the unit was again run, and in 7-hr. operation obtained a load of 46,000 kw.

A shutdown was then decided upon to increase the front wall air port area, reduce the reheat surface and substitute waterwall surface for it, and complete an appreciable amount of construction work. This work was completed Nov. 21 and the unit was brought up to a load of 60,000 kw. and continued in operation for nearly four consecutive months with varying loads. System load did not permit loading the unit to capacity until February, when 82,000 kw. were carried. No unexpected difficulties were experienced.

A table in the report summarizes monthly averages that were assembled every day to aid in economical operation of the plant. These data show that 10,900 B.t.u. per net kw-hr. is about the ultimate economy level for this plant. (This is the lowest heat consumption rate of any power plant operating on the steam cycle—Editor.) Over-all turbine efficiency ratio, including generator losses, is about 84%. Boiler efficiency, though helped by rather low excess air, has been handicapped by air-heater clogging, reasons for which have not been definitely determined. Carbon losses are not particularly low. Peak boiler-feed-pump efficiency is 70%.

During April and May, load conditions made necessary 30-hr. week-end shutdown. Two hours previous to shutdown, the steam temperatures were slowly decreased 100 deg. by stopping end burners and increasing excess air. Resulting slight steam leakage through the leak-off steam-pipe joints caused discontinuance of this practice, after which no effort was made to lower the temperature before stopping.



Heat-rate performance at Port Washington

In starting up, the unit is usually synchronized within 45 min. after warming is commenced. Throttle and reheat temperatures are increased as nearly as practicable 100 deg. per hr. when starting.

To overcome the initial difficulty encountered in holding reheat temperature down, a total of 12% of the original reheater surface was removed and replaced by waterwall surface for which provision had been in the original design. At the same time the front-wall air port area was increased two-thirds to give better flame distribution.

Corrugated Monel-metal hand hole plate gaskets were found positively unsuited for 825 deg. service. They cracked at stress points, and some blew out after 4,000 hr. of service. Mild-steel gaskets were used in their place. Material consisting essentially of 70% copper and 30% nickel had been used as gasket material between phonographic faces. Creep of the gasket metal in to the serrations caused loosening of the bolts and ultimate leaking of the joint.

Large furnace volume and heating surface on all sides has resulted in relatively low furnace temperatures and prevented accumulation of troublesome ash deposits. The first row of boiler tubes has never been lanced.

Water level in the boiler is regulated manually with the aid of a steam-flow water-flow meter. Feedwater control valves are motor operated from pushbuttons on the boiler-operating board.

The feed water system is simple in spite of five stages of feed heating. In place of the two and sometimes three stages of pumping, that have been used in plants of this type, a single-stage of pumping feeds the boiler directly. A "two condenser" water rate of 5.5 lb. per kw.hr. emphasizes the gains made possible through feed water heating.

Discussion

The excellent performance at Port Washington, A. G. Christie said, was due to the attention and care given to the design of detail. He called attention to the absence of economizer and to the use of five points of feedwater heating, which is more than used by any other plant either here or abroad. Best British station (Battersea) has a thermal efficiency of slightly over 29%, which P. W. Thompson pointed out is based on energy generated and includes auxiliary use. H. Dahlstrand felt that absence of turbine difficulties was due largely to the remarkably close control of pressure and temperature.

H. G. Thielscher reported that in 1934, Buzzard Point had produced a kilowatt-hour for 12,728 B.t.u. with 84.6% boiler efficiency, and in 1935 this dropped to 12,405 B.t.u. per kw.-hr. The plant operated for 6 months without requiring a shutdown and for 1 month with 100% capacity factor. Although operating at the same temperature as Port Washington, Monel-metal gaskets were giving satisfactory service. Trouble has been experienced with the gasket joint in the steam chest, distortion of soot-blower elements and errosion of waterwall protecting blocks at the slag line.

Condenser Test Determines Condensate Superheating

BASED on data collected during nearly one year of testing, on one of the new 50,000-kw. condensers at the Delray No. 3 power-house of Detroit Edison Co., G. H. Van Hengel presented an analysis of the undercooling and superheating of condensate, of heat transfer in the condenser, and developed a method of representing the all-year-round performance of a condenser by a single curve. During the test work, a total of 87 runs were made.

Undercooling or superheating of the condensate is understood as the temperature difference between the steam entering the condenser at its neck and the condensate in the hotwell. In customary practice the temperature of the steam at the condenser neck is taken as saturation temperature corresponding to the absolute pressure at the condenser wall. When this steam temperature, minus the condensate temperature, is positive, there is undercooling, and when negative, superheating. The test results on this condenser disclosed superheating of over 6 deg. during winter operation.

The author pointed out the great variation in temperatures measured at the condenser neck, and also to the fact that pressures measured at the condenser wall are not true static pressures, but include some velocity head.

In view of this, the author stated it is not surprising that the measurement of the superheat of the condensate has been a doubtful one, that the test data proved that if it is referred to the static pressure taken at the condenser neck it can really exist, and that it increases with the velocity head of the steam at the condenser neck. The author suggested that in considering condensate undercooling or superheating, hotwell temperature should be referred to the *total* pressure at some initial point, and that in this way temperature recoverable from the steam velocity is not neglected.

The heat-transfer coefficient can be replaced by resistivity to heat flow, which is simpler to calculate and more accurately measured. The inlet resistivity is the ratio of the temperature difference of the condensate and inlet water to the internal heat loading (heat loading is defined as the heat transferred at the inside surface of the tube per unit area and time). This inlet resistivity, plotted as a function of the Reynolds number based on the water-inlet temperature, gives a good curve to establish all-year-round performance of a condenser. This curve for the Delray

condenser is shown in the illustration.

R. A. Bolin expressed the belief that because of common usage, heat-transfer coefficients would have been easier to understand than resistivity as used in the paper. Likewise, use of external surface instead of internal surface in expressing heat transfer would cause less confusion. The proposed performance curves of inlet-temperature difference plotted against Reynolds number were of no use to the designer and offers no advantage as a method of expressing condenser guarantees. G. C. Eaton uses curves similar to those shown by the author, in which initial temperature difference is plotted against internal heat loading to establish performance. He felt the author should not have neglected condenser dirtiness. K. F. Weckes questioned accuracy of the thermocouple and glass thermometer temperature reading to the degree reported. D. W. W. Morgan recalled tests of other condensers where superheating of condensate had been encountered and cautioned against efforts to secure condensate superheating at the expense of condenser performance with respect to vacuum produced.

In closing, Mr. Van Hengel pointed out that the proposed performance curve was intended for use by the operator and not the designer. Internal surface was used because it is theoretically more correct. He said he was not satisfied with the accuracy of the pressure and temperature measurements at the condenser neck and that data are needed on effect of velocity on temperature measurement.

Data for the Design of Steam-Generating Units

PROGRESS in the development of steam-generating units must be made step by step, operating experience of one design leading to the development of the next. It is obvious that if there is to be progress, ventures must be made into new territories. The hazards of failures of such ventures can be greatly reduced by careful deductions from known facts and extrapolation of actual operating data. B. J. Cross, in "Collection and Evaluation of Data for the Design of Steam-Generating Units," indicates some of the difficulties and the care necessary in making field measurements to obtain useful operating data.

The problem of design in the steam-generating unit begins with the furnace. In units of recent design, 40 to 50% of the available heat in the fuel is absorbed in the furnace. From a consideration of combustion only, the rating or duty of a furnace is expressed by the heat liberated per cubic foot of combustion space. Considered as a heat-absorbing unit, the rating of a furnace is the heat liberated per square foot of radiant heat-absorbing surface.

Transfer of heat in the furnace is principally by radiation and takes place according to the Stephan-Boltzmann law, involving the difference in the fourth power of the absolute temperatures of the radiating surfaces. In discussing the applications of this law, it is pointed out that the furnace temperature to be used is the average corresponding to the average rate of heat absorption, and that this temperature does not exist as such.

Measurement of outlet-furnace temperature, because of the adjacent cooler surfaces, is liable to radiation error. Theoretically, with any instrument having a mass exposed to the gas, the true temperature will never be indicated. Because of the small mass possible, the thermocouple is well adapted to the measurement of furnace temperatures. For the furnace-outlet temperature thermocouples of platinum and platinum alloy are necessary, preferably in water-cooled mountings. With such couples, wire diameters as low as 0.005 in. may be used. One difficulty experienced with thermocouples is due to slag building up on the wire and increasing the effective diameter. False reading results because of the shielding effect and increased radiation.

The paper further discusses the heat transferred by convention in the boiler proper, the superheater, the economizer and the air preheater.

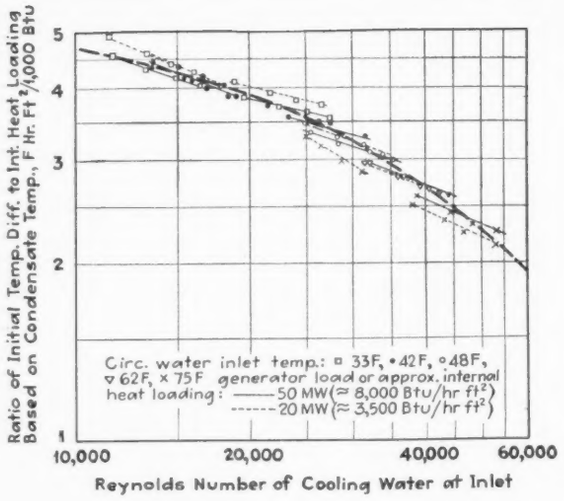
Discussion

Dean R. L. Spencer recounted the difficulties he had had in measuring gas temperature in boiler passes due to radiation to the boiler tubes. He indicated that he had made measurements with thermocouples of several different diameters, and that these different size thermocouples gave different temperatures. By plotting a curve through these temperatures and extending the curve to zero diameter thermocouple, he obtained what he believed was a true temperature.

Cinder Catchers

THE Fuel Panel Discussion Tuesday afternoon included a number of topics related to cinder catchers and dust collectors.

C. W. Hedberg explained that the Cottrell precipitator is now placed between the preheater and the induced-draft fans, thus reducing fan erosion and permitting the precipitator to be wholly within the building. Efficiencies run 90 to 95%, with maintenance costs under a cent per ton of coal burned. Mr. Derry said that the Sturtevant cinder-vane fan, which utilizes changes in flow to separate dust, was first installed at 59th Street Station in 1918. Draft loss is small and only minor modifications of blades are required and efficiency is reduced less than 5%, but blade abrasion is rapid, blade strength is low, and dust-separating efficiency is low in small sizes. There is also some clogging of the necessarily small gas passages.


Ratio of Initial Temp. Diff. to Int. Heat Loading Based on Condensate Temp., F Hr. Ft²/1,000 Btu
5
4
3
2
1
Circ. water inlet temp.: □ 33F, • 42F, ○ 48F, ▽ 62F, × 75F generator load or approx. internal heat loading: —— 50 MW (≃ 8,000 Btu/hr ft²) ------ 20 MW (≃ 3,500 Btu/hr ft²)
10,000
20,000
40,000
60,000
Reynolds Number of Cooling Water at Inlet

Suggested method of showing condenser performance under all operating conditions

Dust losers, not dust collectors, is the proper name for dust catchers, according to L. C. Whiton, Jr. The quality of the dust which escapes the catcher is as important as the quantity. Mr. Whiton described two types of catchers, the skimmer and the multi-cyclone. The first is a three part unit with a concentrator, skimmer and precipitator. If single circulation is used, efficiencies are in the order of 72%; with recirculation they rise to around 88. The multi-cyclone uses a number of small high-efficiency cyclones operating at high velocity for maximum efficiency. Control is either by cutting out a group of cyclones or by dampering to the periphery.

J. R. King of Detroit Edison dealt with that difficult problem—what to do with fly-ash after it is taken out of flue gas. At Trenton Channel, 500 tons of fly-ash must be disposed of each week. Experiments have led to development of two apparently possible methods of use, as a base for concrete, or for building blocks. This at least pays the expense of hauling.

The Hell Gate washers, explained J. J. Grob, have water sprays just ahead of the point at which flue gas is made to change direction. Tide water is sprayed against the dust-laden gas in a lead-lined chamber, then the moisture is removed by a corrugated-plate eliminator. Three units are in successful operation.

The 6-year-old Pease Anthony installation at Kneeland St. heating plant is working out very well, according to Max Engle. Elimination is highly satisfactory, even in this commercial district. All plant waste water, from sootblowing, etc., included, is recirculated through the washer as make-up. Acid-brick linings have worked out as best, with volcanic lava nozzles. Nozzles last three to four years.

Stanley Brown posed an interesting question: Is it better to take out the largest possible quantity of dust particles of nuisance size, or is it better to take out all particles in smaller quantity? Efficiency in the second case may be higher, but actual results are better in the first.

Ollison Craig explained that extruded carbon plates are now being used in the Riley washer with a chemical stoneware brick sides set in acid-proof cement. Nothing else was able to resist the combination of acids encountered in washing. At normal capacity, this unit now uses about 2½ gal. of water per 1,000 cu.ft. of gas.

Interpretations of Creep

THE creep of metals (that is the rate of change of deformation) has long been known to occur, but accurate data on its extent have not been available, in fact cannot be obtained except by long-time studies. With increasingly high pressures and tem-

peratures, and consequent closer clearances, particularly between rotating and stationary parts of steam turbines, however, now make creep a major factor in design.

Intensive study of the phenomenon has resulted in sufficient data so that reliable conclusions can now be drawn. C. Richard Soderberg, in "The Interpretation of Creep Tests for Machine Design," presented a new method of interpreting creep-test data, utilizing a logical theory of plastic flow in poly-crystalline materials to which empirical results from actual tests can be applied. Strain hardening does not appear to be as important a factor in creep as it was once considered, other factors having more to do with it, and thus requiring a new interpretation of test results.

Tests show that as stress is increased by arithmetical increments, creep for a given time and temperature is increased by geometrical increments. For example, at 850 deg. F., an increase of 2,500 lb. per sq.in. will, for any given time, approximately double the creep in 0.35 C cast steel. The corresponding figure for cast carbon molybdenum steel and forged 13% chromium steel is about 5,400 lb. per sq.in.

As temperature is increased by arithmetical increments, creep for any given time and stress is increased by geometrical increments. For example, at high temperatures, an increase of 12 deg. F. for a given time and stress will approximately double the creep in 0.35 C cast steel. For cast carbon-molybdenum steel the figure is 22 deg., for low-carbon chromium steel it is 48 deg.

Creep Curve and Stability

S. H. Weaver, in "The Creep Curve and Stability of Steels at Constant Stress and Temperature," pointed out that the creep rate for steels at constant stress and elevated temperature is composed of (1) the strain hardening with a rate which varies inversely with time, and (2) an asymptotic constant creep rate. Their sum gives the creep rate at any time as well as the formula for the creep-extension curve. For steels with a physical or structural change during creep, a third quantity must be added to the creep-extension formula, the test value of the quantity indicating the degree of instability of the test metal.

To illustrate four of the principal types of instability, Mr. Weaver presented four sets of long-time creep tests extending from 5,500 hr. to 5 yr., showing changes due to carbide spheroidization, ferritic banding, dendrites, and alloy segregations.

Discussion

Mr. Soderberg, discussing Mr. Weaver's paper (which was presented first), commented upon the unusually long test data available as of much more value than the usual short-time data upon which long-time conclusions must be based. Mr. Cantor showed if the log of the strain is plotted against the log of time, three types of plot are obtained, a concave (showing softening), a straight line, and a convex (showing hardening). Prof. Marra of Rutgers pointed out the correlation between Mr. Soderberg's and the Bailey and St. Venant's theories, showing that the Soderberg theory is easier to use although test data backing it are not so complete. Mr. Nadai brought out that material changes may occur as a result of time alone, without change in stress or temperature. Mr. Karelitz explained that creep-test data cannot be applied directly to practice in many cases because they hold stress constant, while it varies in such cases as pipelines. Mr. Stern found that creep is a straight line in aluminum, if initial deformation is disregarded.

The Subcommittee on the Effect of Temperature on Metals presented a progress report as a series of discussions on both short-time impact and long-time creep tests on various materials, particularly the standard 0.35 C test steel. One report from seven laboratories showed the deformation rate at 1200 deg. continually increasing.

Turbine Regulation

Application of supervisory instruments described. Governing superposition turbines discussed, turbine history related

Turbine Supervisory Instruments

Two papers described turbine supervisory instruments and discussed information obtained from the records made by their application to large and small turbines. The instruments discussed were eccentricity meters (which indicate and record the shaft eccentricity), instruments for indicating and recording the magnitude of vibration at the turbine bearing pedestals, instruments for recording axial expansion of the turbine cylinder, and instruments for detecting and amplifying noise made by the blading and glands of the turbine. J. L. Roberts and C. D. Greentree described instruments of this type developed by General Electric Co. and applied to the 160,000-kw. unit at Hudson Ave. H. Steen-Johnsen discussed instruments for the same purpose developed by Westinghouse Electric & Mfg. Co. and applied to the 165,000-kw. turbine at Richmond.

Roberts and Greentree show charts taken by these instruments during the starting-up period of the Hudson Ave. turbine. During turning-gear operation, the record shows relatively small eccentricities that vary from 0.005 to 0.007 in. During the period the turbine is being brought up to speed, the record shows eccentricities to have increased slightly to 0.008 in.

The final phase of an operation is loading the turbine. On this particular turbine the increasing load almost invariably caused the shaft eccentricity first to decrease to zero, then to increase to a value roughly proportional to the rate of load increase. When the load is held relatively constant the curvature works out of the shaft as the forces and temperature become relatively constant.

One of the most startling observations appearing on these and similar records is that bearing-vibration amplitude does not respond, except in a very minor degree, to a large increase in eccentricity in the shaft. It appears as though the rotor acted like a free-floating body with little or no reaction on its points of support.

Duration of turning-gear operation and the amount of eccentricity when the turbine is first rolled by steam has a decided effect on the subsequent values of eccentricity. The longer the turning-gear period, the smaller the eccentricity at the end of this period, and in consequence the less the eccentricity during the coming-up-to-speed period.

Records from these instruments during special loading sequence on the turbine led to the conclusion that the low-pressure outboard bearing was low. When the turbine was subsequently taken down for overhauling, it was found that this bearing had settled 0.021 in.

In discussing the application and records made by the supervising instrument applied to the 165,000-kw. turbine at Richmond Station, Mr. Steen-Johnsen observed that when the turbine was put in service it was found that with a turning device on the machine there was no great need for an eccentricity meter. The spindle was generally straight enough so as not to require any further attention.

The eccentricity instrument, however, brought out some very interesting points. The spindle moved around in the bearing considerably more than anticipated. As the speed was increased from slow rolling there was a uniform movement of the rotor shaft toward the left-hand side of the machine. When the oil temperature came up, there was a tendency for the spindle to move backward toward the center, and as load was applied the movement toward the center continued. The journal, however, never returned to the standstill position.

The vibration recorder has been of real value and little trouble has been experienced with it. It has been most useful in bringing the machine through critical speed with a minimum of vibration.

Information given by the expansion meter has proved of great assistance during starting period, in that it shows accurately whether or not the cylinder parts are expanding normally and gives warning that the sliding joint is not functioning properly. The instrument readily shows the difference between greasing the pedestal and letting it run dry.

Discussion

C. R. Soderberg expressed the opinion that supervisory instruments can only be justified for large turbines. There use so far has demonstrated their value to designers and information has been obtained that otherwise would not have been discovered. They have shown clearly the importance of the turning gear. J.

N. Landis indicated that development of these instruments had been started by G. L. Knight and that it had taken longer than anticipated. The instruments at Hudson Ave. have only recently been accepted. The eccentricity meter is doing its work well, although its principal value is for the designer. The vibration recorder and expansion meter are very useful operating instruments. T. C. Rathbone pointed out that expansion is not always even and that therefore two expansion meters measuring both axial and transverse movements may be required. He asked whether use of Magnaflux in turbine inspections would interfere with operation of the eccentricity recorder.

In closing, J. L. Roberts said testing with Magnaflux would not interfere with the eccentricity recorder. Eccentricity recorders have been furnished for turbines as small as 10,000 kw. One company has requested an alarm be incorporated in the supervisory instruments and they are now building one.

Superposed Turbine Regulation Problems

THE superposed back-pressure turbine presents problems of control which are more difficult than those encountered for condenser turbines. Heat drops are usually low, leading to enormous steam flows even for moderate capacity. Since there is no limitation imposed in connection with exhaust area, 3,600 r.p.m. turbines can be used up to the limit of the generator capacity. This speed leads to abnormally low spindle inertia as compared to condensing turbines. A. F. Schwendner and A. A. Luoma discussed problems of controlling superposed turbines of this type.

With the turbine on the line carrying the load, changes in steam flow will depend on exhaust steam demand and the type of regulation required by the particular power plant. When the superposed turbine is run as an individual unit exhausting to the low-pressure boiler header the steam flow, and consequent load carried by the superposed turbine, is determined by the power-plant load and steam demand, and is controlled by the governor speed changer. In another case, only the superposed turbine supplies steam to one or several low-pressure turbines. In this case the governor will have to respond to varying flow demand of the low-pressure unit and keep the pressure in the low-pressure header within close limits. Load on the superposed turbine will be determined by the steam demand of the low-pressure unit and will be controlled by a steam governor, which will also respond to exhaust-pressure changes. Finally, there is the combination where the superposed turbine is electrically tied to one or more low-pressure turbines, which combination will have the governing characteristics of a condensing unit, and is not considered in this paper.

The remainder of the paper was divided into two general parts, one describing the hydraulic governing system on Westinghouse superposed turbines, and the other devoted to a theoretical analysis, first of synchronizing stability, and, second, stability on the line with an exhaust-pressure regulator in action.

Discussion

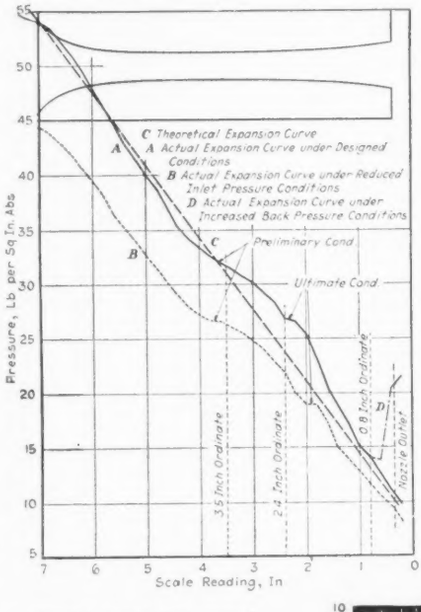
C. R. Soderberg pointed out that the standard 1,800-r.p.m. turbine accelerates at the rate of 150 to 200 r.p.m. per sec. when full load is dumped, and that in comparison the 3,600-r.p.m. modern superposition turbine accelerates 765 r.p.m. per sec. This imposes a more difficult duty on the governor to hold speed within the 10% limit at which the overspeed trips are set. T. C. Rathbone asked whether modern superposition turbines would require further consideration of the inertia governor.

In closing, the author said that if flow is not too great, modern 3,600-r.p.m. turbines have a speed rise of 8.5 to 9%. To take care of the condition that may arise when flows become too great, an electrical device that uses rate of load reduction as a means of governing is being developed.

Undercooling In Nozzles

IN 1933 J. I. Yellott reported the results of researches made to investigate drop size in supersaturation by studying the flow of low-pressure steam through nozzles similar to those used in turbines. Using much of Yellott's equipment, J. T. Rettaliata has extended this work for the purpose of ascertaining whether drops could be made to grow in a specially designed nozzle, to determine accurately whether initial condensation was actually occurring in a nozzle at the point where the eye detected it, and to investigate the influence of wall roughness on flow of steam in nozzles. The results of this work he reported in, "Undercooling in Steam Nozzles."

It was found that roughness of the nozzle caused a retardation of steam flow and causes the Wilson line to occur at the 3.2% moisture line on the Mollier diagram instead of at the 3.7% moisture line, as was found for a nozzle with a smooth wall. In a specially designed nozzle with a long expansion throat, drop growth was accomplished as evidenced by the complete visible spectrum which resulted from the scattering of light by the expanding steam in this nozzle. These results show the desirability of eliminating, in actual turbine design, any long parallel-sided passages that would give the droplets time to grow and so cause more rapid deterioration of the low-pressure turbine blading. Photographs of the condensation region showed that condensation is not occurring at any point previous to where the eye sees it.


C Theoretical Expansion Curve
A Actual Expansion Curve under Designed Conditions
B Actual Expansion Curve under Reduced Inlet Pressure Conditions
D Actual Expansion Curve under Increased Back Pressure Conditions
Preliminary Cond
Ultimate Cond
0.8 Inch Ordinate
3.5 Inch Ordinate
2.4 Inch Ordinate
Nozzle Outlet
Pressure, Lb. per Sq. In. Abs
Scale Reading, In

Special nozzle that caused growth of drop size

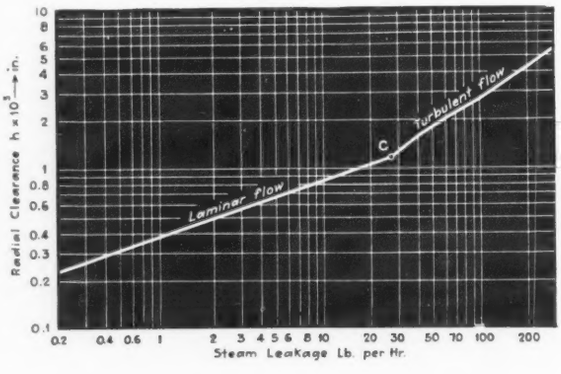
Discussion

J. Yellot said he had found an error in his previous work due to the location of pressure connection with respect to location of thermometer reading. He showed a curve with corrected value indicating the Wilson line to be a zone between the 4 and 4.5% moisture lines. C. H. Coogan reported he had found the Wilson line at the 4.3% moisture line during work on steam-jet air ejectors. He found the nozzle contour has very important effect on condensation time. A. Egli said that the turbine designer needed information on drop size and how it is related to variables and how it varies along length of nozzle. J. H. Keenan suggested that too much stress should not be placed on the time factor in growth of drop and consider more closely what it is that starts condensation.

In closing, Rettaliata said drop size can be determined but this would require complete redesign of apparatus.

Leakage Through Narrow Channels

FLOW through narrow channels is encountered whenever there is leakage. Examples are flow through valve steam packings, ring glands of rotating shafts, clearance space between plunger and cylinder, etc. An investigation of flow of this character was undertaken by Adolf Egli and the results reported in a paper presented by title only. The tests were made to determine the flow through the narrow annulus formed by a stem and bushing using both steam and air. The figure shows flow for a 2-in. diam., 5-in. long bushing with various clearances with steam at 400 lb. pressure and 650 deg. F. Up to point *C* the flow is laminar and beyond this it is turbulent. Leakage is very effectively reduced if the clearance can be decreased below this critical point.



Effect of radial clearance on the leakage of superheated steam through a valve-stem bushing

More Research on EMBRITTLEMENT

FOR SOME YEARS the annual meetings of the A.S.M.E. have featured the sessions of the "Joint Research Committee on Boiler Feed Water Studies." Papers presented, while often quite technical in character, have dealt with problems of great ultimate importance to power engineers. Chief of these is the problem of "embrittlement."

Progress Report

GREAT interest was shown in the progress report, presented by A. A. Berk and W. C. Schroeder, on an investigation being carried out in New Brunswick, N. J., at the Non-Metallic Minerals Experiment Station of the Bureau of Mines. C. H. Fellows, chairman of the meeting, stressed the importance of the New Brunswick investigations. Their object, he said, is not to find an immediate practical cure for embrittlement, but rather to lay a solid foundation of fact, upon which future practical progress may be based.

Dr. Schroeder said that iron, exposed to water substantially free from dissolved oxygen, produces hydrogen and iron oxide (Fe_3O_4). However, this reaction does not continue indefinitely when iron is placed in pure water, because the iron oxide forms a protective film. This film, Dr. Schroeder pointed out, is more soluble in concentrated sodium-hydroxide solutions than in water alone. It might therefore be expected that such solutions would permit the disintegration of the iron to continue.

To test this assumption, screened saw cuttings of iron were loaded in a bomb and there kept in motion for 16 hours in a solution of caustic soda at 250 deg. C. After cooling, the bomb pressure was determined as a measure of the amount of hydrogen produced, and hence of the amount of iron reduced to iron oxide. It was found that the hydrogen produced increased with the caustic concentration until (at 50 grams of sodium hydroxide per 100 grams of water) practically all of the fine iron cuttings (between 150 and 200 mesh) were converted to oxide.

Since low concentrations of sodium silicate had been found to play an important part in the experimental production of embrittlement, tests were made on the effect of adding sodium silicate to the sodium-hydroxide solution. Small additions of silicate increased the hydrogen, but at a certain silicate concentration the amount of hydrogen produced dropped to about one-third that produced with the pure caustic solution.

Neither space nor the general character of this summary permits outlining the further experiments. However, a summary of some of the conclusions reached by Messrs. Berk and Schroeder should be of interest.

The amount of hydrogen released by a pure solution of sodium hydroxide increased with the hydroxide concentration. The addition of small amounts of sodium silicate to a fixed solution of sodium hydroxide first causes a sharp rise, and then, with further additions, a very large drop.

From the data now available it is possible to suggest a number of mechanisms by which sodium hydroxide and sodium silicate may enter into the embrittlement reaction. One is that the sodium silicate may cover certain areas and cause electrolytic corrosion of the uncovered areas. There is a definite tendency to attack the grain boundaries, indicating that these are the exposed or uncovered areas. It was not the author's purpose to attempt the formulation of complete mechanism for embrittlement at the present time.

After Dr. Schroeder's presentation of the paper, Dr. Berk told of another phase of the experimental work. A crack developed in one of the bombs used for testing tensile specimens. The crack ran up to the solution level. Stresses were low, not over 5,000 lb. per sq.in. The main crack was about 0.001 in. in width. Dr. Berk concluded that solutions do cause inter-crystalline corrosion, but that other factors also may operate. He felt that stress has little to do with this so-called embrittlement.

Discussion

Dr. Schroeder's experiments confirmed certain experiments made by the New York Steam Co. Relatively pure iron, put in contact with relatively pure water, developed films containing iron and silica. The silica presumably came from the glass vessel in which the experiments were conducted.

Dr. Schroeder explained that "embrittlement" is a somewhat misleading term for the phenomenon of inter-crystalline cracking. He felt that hydrogen is not a major factor in this cracking.

Dr. Partridge noted that we have always assumed a heavy concentration of caustic in boiler seams, and suggested that "embrittlement" might not actually require a high concentration.

Sodium Sulphite

THE program called for the presentation of a paper, by Prof. F. G. Straub, on the 'Reactions of Sodium Sulphite Under Boiler Operating Conditions." Dr. Fellows explained that this paper had been withdrawn, but that the results of the sulphite investigation will be made available later.

Metals Fight Corrosion

A FEATURE of the A.S.M.E. meeting was a symposium on corrosion-resistant metals. Five papers were presented.

It seems unlikely, explained Mr. Speller, introducing the symposium, that we shall find one metal or one general remedy for all kinds of corrosion. For such service, the engineer must select the metal that will do the job at the lowest *ultimate* cost (not first cost).

Stainless Steel

DISCUSSING corrosion-resistant steels and irons, J. H. Critchett emphasized that all stainless steels depend upon chromium for their major resistance properties. Chromium steels are resistant only where oxygen is available to produce and maintain a film of chromium oxide, and where this film is not removed by chemical solution or by a combination of abrasion and corrosion. The chemical resistance of chromium ("stainless") steels increases with chromium content, but not in simple proportion. Thus 12% chromium alloy is markedly superior to 11%, and 25% to 22%.

Such elements as molybdenum, tungsten and vanadium are used particularly to increase the mechanical properties, more especially strength at high temperature. Copper is widely used to tone up corrosion resistance, particularly against carbonic acid and other weak organic acids.

Steels containing 18% chromium and 8% nickel are the most popular of all the stainless varieties, said Mr. Critchett. They combine great general corrosion resistance and remarkable physical properties, are readily rolled, fabricated and welded. Ductility is very high. They are resistant to practically all the media to which straight 18% chromium steels are resistant, and, in addition, show excellent resistance to many corrosive solutions.

Zinc

DISCUSSING zinc in the chemical industries, E. A. Anderson, of New Jersey Zinc Co., mentioned the use of zinc plates in marine boilers as protection. The protection, he said, is not due to electrolytic action, but to the fact that zinc uses up the oxygen present in the water.

Aluminum

ALUMINUM alloys, it was pointed out by E. H. Dix and R. B. Mears, are corrosion-resistant under some conditions, but not all. The resistance to corrosion comes mainly from the film of aluminum oxide. This film is generally self-repairing if sufficient oxygen is present. Ammonia solutions, if free of heavy metals and chlorides, do not seriously attack aluminum, so that it has been successfully employed in condensers for ammonia water mixtures and in refrigerating systems using ammonia. Aluminum is inert toward most anhydrous gases. Its use in refrigerating units employing sulphur-dioxide or ammonia has been approved by the Underwriters Laboratories.

Copper, Brass, Bronze

MUCH information on the applications of copper and copper-base alloys was contained in the paper by R. L. Wilkins. The bulk of copper used in the U. S., he said, is electrolytic. Phosphor deoxidized coppers are easier to weld than electrolytic coppers. However, an oxygen-free copper now on the market has the weldability of phorphorus deoxidized coppers and the high electrical conductivity of electrolytic copper.

In general, it can be stated that copper withstands atmospheric corrosion and seawater corrosion, as well as any commercially available metal. However, ammonia, carbon dioxide and certain other substances, in the presence of moisture

and in relatively low concentration, will corrode copper actively.

Brasses are used in applications where the higher strength or lower cost is obtainable without sacrificing properties essential to the job. Commercial brasses range from 95% copper and 5% zinc to 55% copper and 45% zinc. There are hundreds of varieties. Seventy per cent copper gives maximum ductility, while 60 to 63% copper gives maximum strength. Lead is frequently added to increase machineability. Additions of tin and aluminum have little effect on physical properties but increase resistance to certain kinds of corrosion.

Under special conditions, certain brass compositions are more resistant than copper. An example is Admiralty metal exposed to the combined action of sea water and oxygen. Brasses containing less than 85% copper, when exposed to acid water, frequently fail by "dezincification," characterized by spongy areas of copper. If the copper content is high enough, dezincification will generally be avoided.

It must also be remembered that there are many varieties of brass, each with special charactersitics. Under given conditions one may fail, and another succeed. There are also many copper-base alloys containing no zinc—principally copper-silicon alloys, tin bronzes, aluminum bronzes, cupro nickels, and nickel silvers. The copper-silicon alloys offer a material of high strength and excellent corrosion resistance with strength about equal to that of mild steel.

Alloys of copper and nickel, termed "cupro nickels," are widely used in condensers and heat exchangers, particularly for power-plant condensers. Most commonly these contain from 20 to 30% nickel. Condenser tubes of 70% copper and 30% nickel, are extensively used.

In some sections of the country, copper, brass or other non-ferrous pipe will show great economies over iron or steel for handling industrial and domestic fresh-water supply. In others there may be no advantage. This applies particularly to waters of low permanent hardness and high CO_2 content.

Nickel

Discussing nickel and nickel-base alloys, F. L. LaQue said that practically all high-nickel alloys are notable for their strength. High-strength regular Monel and K-Monel have mechanical properties comparable with those of high-strength alloy steels. In addition they retain strength, ductlitiy and toughness over a wide range of temperature conditions. Nickel is highly resistant to corrosion by natural, distilled, or sea water. It is practically untouched by alkalies, notably caustic soda. Nickel is not attacked by anhydrous ammonia, and is resistant to aqueous ammonia or ammonium hydroxide in concentrations under 1%. No dry gases are actively corrosive to nickel at ordinary temperatures, but sulphur dioxide and ammonia are appreciably corrosive when mixed with water or condenser water vapor.

Monel, commercially the most important of the nickel-copper alloys, has high strength and corrosion resistance. Monel is more resistant than nickel under reducing conditions, and more resistant than copper under oxidizing conditions. It is practically unaffected by atmospheric exposure. Monel is very resistant to corrosion by all sorts of waters, notably sea water, also refrigerating brines, and is used for valves, pump parts and ice-making machines. It is unaffected by the corrosive and erosive action of steam at temperatures up to 700 to 800 deg. F. Steam applications include turbine blading, valve trim, gaskets and orifice plates.

Oil Rings—Quiet

At a Machinery and Springs Session Wednesday afternoon, two papers contained data of interest to the power engineer, the rest of the program being devoted to spring materials and research.

Grooved Oil Rings

L. M. Tichvinsky and R. Baudry of Westinghouse Research Labs. prepared "Performance of Oil Rings," presented by Mr. Tichvinsky. He described a new type of trapezoidal cross-section grooved oil ring for lubricating synchronous condensers for Los Angeles. The ring is essentially like a top hat in crosssection, with the brim somewhat thicker than usual and running in contact with the journal. On the contact surface are several deep narrow grooves which aid in delivering a much larger amount of oil than did previous rings. This development and test work, begun under supervision of Dr. Karelitz, started with conventional ring shapes and progressed to the present type. The general sizes were tested, one a 15-in. diameter ring, the other 30 in. in diameter, running on 9 and 18 in. journals respectively. Test results show the smooth ring is better than the relieved or other similar types, but in turn is not as good as the grooved. This large-diameter ring moves at the same speed as the journal surface up to about 600 r.p.m., then begins to slip. Grooved rings here begin to deliver more oil and continue to do so through the higher speed ranges.

Discussion

Mayo D. Hersey of Kinsbury Machine Works showed how he had worked out mathematical formulae using test results from the paper to permit prediction of results with given ring and journal sizes. While much of this is of course still tentative, it nevertheless leads toward practical application of the information obtained. Dr. G. B. Karelitz of Columbia pointed out that the authors had not described minutely the shape of the oil path around the ring. This would be of much value to those who plan to utilize this research data for practical application because if some sort of catching or scraping arrangement is not used to catch the oil, it will simply follow the ring around into the sump again, doing nothing beyond some cooling.

Quieting Machinery

It is a fairly straightforward matter to describe any particular instance of quieting. Such a description, however, does not give an adequate idea of the great variety of factors encountered in practical noise problems and the extreme flexibility and power of acoustical measurements in dealing with them. Earnest J. Abbott, in preparing "Quieting Machinery," for the above reason, outlined the solution of twelve machinery sound problems that he has contacted during the past decade. Each example is quite complete in itself, the particular problem is stated, the important factors mentioned, the method of attack indicated, and the results outlined. Each example was selected because it illustrates differences in aim, controlling factors, point of attack, technique of measurement, type of results or method of correction. At the end of each example are listed some of the fundamentals illustrated. Among the problems discussed are the following, all of interest to power engineers. Noise from an oil storage tank fed by a gear-driven pump, noise from an electrical substation, and noise from a reduction gear on a turbo-generator set.

In this latter problem the work was done to determine noise specifications for the gear unit, so that the central station company could include them in the order for the next turbo-generator unit. Sound level measurements and frequency analysis were made on these units, which consisted of a high-and-low-pressure turbine operating at different speeds and driving a single gear through two pinions.

These measurements showed that the machine had very prominent musical components. The notes were all harmonics of two fundamental frequencies. Surprisingly enough, those fundamental frequencies did not correspond to frequencies of tooth contact, but, instead, were related to frequencies of rotation. The two series of notes were harmonics of pinion speeds. No notes could be detected which corresponded to bull gear speed. Each of four different gear sets showed an entirely different acoustical spectrum. When one set was reconditioned by taking a small cut from the working side of the teeth, the acoustical spectrum was entirely different from what it was before.

From the above observations the following conclusions were drawn: (a) Errors in tooth contact were not responsible for the noise; (b) misalignment or deflection under the load was not responsible for noise; (c) imperfect balance was not responsible for noise; (d) pinions were responsible for the noise, not the gear; (e) the particular pinion responsible for each note was obvious; (f) notes were not caused by resonance of the shaft, webs, casing, etc.; (g) the information indicated quite clearly that the errors causing the noise were produced by the machine on which the gears were cut, particularly the machine used in cutting the pinions. Further, the errors were not in the form of the cutter, but in the mechanism by which the blank was indexed from one tooth to the next, and by which the tooth spiral was generated.

Discussion

Dr. Abbott departed from the usual custom of presenting a paper by giving his hearers a well-rounded lecture on sound phenomena, how noise is traced and located, how disagreeable noise conditions are corrected, etc., and expanding upon the details of the typical problems described in his paper. Among other things, he pointed out that the human ear cannot distinguish even relatively large differences in sound volume and that man cannot retain an accurate recollection of a sound level.

Pump Testing Features HYDRAULIC SESSION

Two papers described the new hydraulic laboratory of the California Institute of Technology and the work done there during the last two years, testing models of pumps to operate on the new Colorado River Aqueduct of the Metropolitan Water District of Southern California

Hydraulic Laboratory at Calif. Inst. of Technology

THE Metropolitan Water District of Southern California has under construction a water-supply system that will eventually bring one billion gallons of water per day from the Colorado River, a distance of 300 mi., to Los Angeles and other Southern California cities. This water must be lifted against a total head of nearly 1,700 ft. in five pumping stations. To operate these pumps will require a total of nearly 400,000-hp. motor capacity, which classes the project as the largest pumping undertaking in existence.

Faced with extraordinarily difficult problems in connection with these pumping plants, the Metropolitan Water District and the California Institute of Technology entered into a joint hydraulic-laboratory enterprise. This laboratory was described by R. T. Knapp, in a paper, the "Hydraulic Machinery Laboratory at the California Institute of Technology."

This laboratory was designed essentially to work with problems involving high heads, high speeds and moderately large powers and rates of flow. The following classes of problems are within the scope of the equipment and represent the fields of investigation in which the laboratory will be employed after the completion of its original objective:

(1) Pumps or turbines up to 12 cu.ft. per sec. maximum capacity, 700 ft. maximum head, 5,000 r.p.m. maximum speed and 400-hp. maximum power.

(2) Exploration of internal-flow conditins in hydraulic machinery.

(3) Valves, conduits, or fittings investigations at high velocity.

(4) Similar investigations involving non-corrosive liquids other than water, since system is closed and isolated.

(5) In general, problems requiring flows at high Reynolds, numbers and precision of instruments.

The instruments and equipment permits both speed and precision in testing and over-all accuracy of 0.1% being obtainable. For the past two years the laboratory has been used for the study of pumping problems of the Colorado River Aqueduct and included the following:

(1) A comprehensive study of a group of pumps of varying specific speeds and other operating characteristics for the purpose of selecting the proper specifications for pumps in the different stations.

(2) Precision acceptances of both bidders' and contractors' model pumps.

(3) A study of the transient-flow characteristics of the contractors' model pumps in order to ascertain their behavior during emergency conditions, such as power failure and shaft breakage.

(4) Special internal surveys of hydraulic conditions existing within the case, as they effect either structural design or operating efficiency of the unit.

(5) Study of control-valve characteristics throughout the operating range from closed to full open.

(6) Metering investigation.

Flow Characteristics

THE desire for more knowledge of actual flow conditions in the impellers and volutes of centrifugal pumps has long been present in the minds of those interested in the construction or operation of hydraulic machines. This desire has grown more intense as efficiencies have been forced higher and higher, since an increase in efficiency has been more difficult to obtain and has demanded more precise information about the hydraulic behavior within the casing of the machine. Therefore, it is not surprising that many attacks have been made on this problem both from the theoretical and the experimental point of view. However, as yet neither method of approach has yielded entirely satisfactory results, so that additional attempts to supply this knowledge are still definitely needed.

To extend this knowledge, an exhaustive study was made to determine internal flow characteristics of two high-efficiency high head centrifugal pumps of commercial design, which was presented in "Experimental Determination of the Flow Characteristics in the Volutes of Centrifugal Pumps," by R. C. Binder and R. T. Knapp. This study was made in the laboratory previously described. From these studies the authors draw the following conclusions:

(1) There is practically no instantaneous velocity variation in the impeller discharge at normal capacity and only slightly more at low or high capacity during the time of passage of one vane space past a measuring station.

(2) There is a strong circulation between the volute and the impeller clearance space which apparently acts as an energy pump and helps to minimize losses.

(3) For low-capacity conditions, double peak-velocity profiles are found, probably due to a centrifuge action of the shroud.

(4) For normal capacity, the radial-velocity distribution around the volute is relatively uniform, while for high or low capacity, large variations are found.

(5) For low capacity, a high ratio of inflow is observed in the region of the tongue, while for high capacity a high outflow occurs in the same area.

(6) Non-uniform velocity and static-pressure distribution combines to produce unbalanced radial forces on the impeller. Maximum values exist during low-capacity operation, while the forces are at a minimum for normal rate of discharge. At low capacity, the deflection may be about three times that at normal capacity, while at high capacity it might be twice that at normal.

(7) A considerable variation in the deviation between the vane exit and the relative velocity was observed. The average deviation was greatest for low-capacity conditions and least for high-capacity conditions. At normal discharge it was 9 degrees.

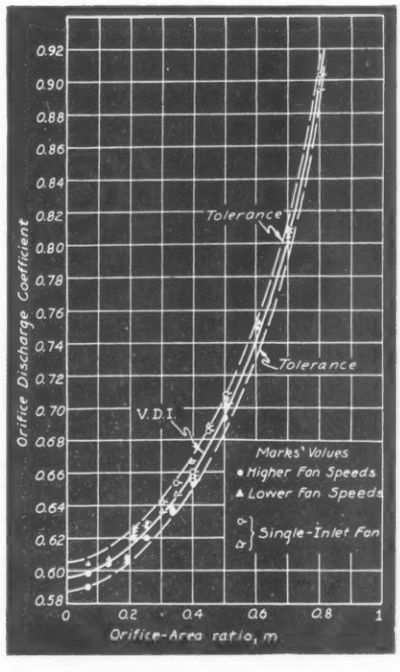
Discussion

In discussion, the accuracy within less than 0.1% obtained for all test reading, was given considerable attention. It was brought out that every effort had been made to get a high degree of accuracy in arranging the laboratory equipment. All the measuring instruments and control are located on the operator's table and readings are taken simultaneously by pushing a button. A great many tests were made to check the accuracy of the individual measuring devices and of the tests. Results of these tests have been so consistent with those expected as to leave little doubt as to their accuracy. It was the concensus of opinion that a great deal of credit is due the engineers who planned the laboratory and were responsible for the minuteness with which the tests have been made, as this work will be reflected in future design and testing of pumps.

Fluid Flow And Aerodynamics

AT THE session on "Fluid Flow and Aerodynamics" Lionel S. Marks, presented his third paper on the flow of air in fan ducts. In the first paper it was established that the normal flow in such ducts is vertical

Discharge coefficients for square-edged orifices recommended in V.D.I. rules, compared with those determined by Lionel S. Marks.



in character and that the use of straighteners is necessary in order to attain a reliable air-volume measurement. The second paper contained proposals for the adoption of a special design of pitot tube as a standard in fan testing and the use of square-edged inlet or discharge orifices for measuring air volume except at or near maximum fan capacity.

In his present paper the results of an extended series of investigations on a simplified form of square-edged orifice are presented. Discharge coefficients obtained in these investigations are identical with those found in extensive German tests and adopted in the standard rules of the V.D.I. and by the International Standards Association, as shown in the figure. This agreement justifies the use of the coefficients for the large-size ducts and the varieties of velocity distribution found in fan-discharge ducts. The substitution of inlet- and discharge-orifice measurements for pitot-tube traverses and the adoption of these coefficients in a fan-testing code would in the opinion of the author greatly shorten and simplify the process of testing a fan and would make it more accurate.

Discussion

Arnold Smith pointd out that inlet orifices are less sensitive than discharge orifices to flow fluctuations caused by fans. S. R. Beitler referred to work he had done on air using orifices calibrated with water. Results were entirely unsatisfacfactory. R. E. Sprenkel expressed the opinion that the curves would have better shown the peculiarities of the orifices if approach velocity had not been included. He compared Marks data with other published work and found it to agree within 1½%. It was pointed out that coefficients are usually high and suggested that tolerance be changed from plus or minus 1½% to plus 2% and minus 1%.

In closing, Prof. Marks said that I.S.A. Standards were being considered for the test code on fans and that he had therefore followed the German practice of including approach velocity. He pointed to the necessity of straighteners, without which errors of as much as 50% may be encountered.

Effect of Venturi-Meter Location On Coefficient of Discharge

W. S. Pardoe presented the results of a series of tests conducted to determine the effects of the location of a venturi-meter on its coefficient of discharge. These results are shown graphically together with sketches of the type of installations and venturi-meters for which the coefficients were determined. It is shown mathematically and experimentally that for normal turbulence and shooting flow, the coefficients are the same as for low-ratio meters, but that for high-ratio meters the coefficient increases from that for shooting flow to the normal value in about 20 diameters of mixing lengths.

Discussion

Arnold Smith presented an analysis from which the effect of helical flow on the venturi-tube coefficient can be predicted. E. Smith objected to the author's use of the term "shooting flow" because of its use in connection with flow in open channels. R. E. Sprenkle felt that information on the effect of installation on all types of meters was badly needed. He referred to a German report which indicated that the effect of bends on venturi meters did not produce errors over ¼%, but the venturi tested was not the same as that tested by Pardoe.

Modified Orifice And Free Discharge

"Modified I.S.A. Orifice With Free Discharge" by M. P. O'Brien and R. G. Folsom, showed results obtained with a modified international standard orifice as used for metering pump discharges. The annular slot for pressure measurement of the standard I.S.A. orifice is replaced in the modified type by a series of slots at the pipe wall and flush with the orifice plate.

Results given in the paper included coefficients obtained with sharp-edge and round-edge orifices with various orifice pipe-diameter ratios and with various approach lengths of pipe. Coefficients obtained with the modified I.S.A. orifice are compared with those of the standard I.S.A. orifice.

Except with short approach lengths and large diameter ratios, the orifice coefficient does not vary with the head in the range tested. With the approach length equal to or greater than 20 diameters of pipe, the coefficient for new pipe showed no progressive trends with head, and the deviation from the average was small. The main deviations were 0.5% or less for all combinations. With an approach length equal to 8 pipe diameters, the coefficients showed no trend with heads below a diameter ratio of 0.6, but above this ratio the coefficients decreased with increase in head.

The shortest approach pipe consisted simply of a short nipple between the orifice holder and the flange of the elbow. With this arrangement the coefficient decreased with increased head at all diameter ratios. With the shortest approach length, the jet was rough and rotated at such a high angular velocity as to cause it to break apart. The coefficient with old corroded 6-in. pipe were high as compared with the other values. The increase in coefficients was only about one-half the value given for pipe roughness in the I.S.A. standard.

Results of a study made to determine the effects of certain installations on the coefficint of discharge of sharp-edge orifices were given by S. R. Beitler and J. E. Overbeck as part of the research work of the joint committee of the American Society of Mechanical Engineers and the American Gas Association on orifice coefficients. The coefficient determinations were made with the orifice plates clamped between flanges made upon one end of pipe so that no appreciable gap existed between the end of the pipe and the orifice plate. Some of the orifice flanges were constructed with a core or recess, which left a gap of an inch or more between the end of the pipe and the orifice plate, this being done to simulate meters of this type now used to a greater or less extent. Results were presented as obtained from the test of such orifices set in 2-, 4- and 8-in. pipe, as well as results from tests of standard reference orifices. The committee in making its report made the following recommendations for orifice flanges:

That the orifice pipe extend through the flange so that there is no recess greater than ¼ in. between the orifice plate and the end of the pipe as measured parallel with the axis of the pipe. If in existing installations there is a recess preceding the orifice plate, either in the orifice flange or between the pipe and the plate, the length of which, parallel to the axis of the pipe, is greater than ¾ in., the orifice coefficient given in this report may be used only if the ratio of the orifice to pipe diameter does not exceed 0.3 for a 2-in. line, 0.4 for a 3-in. and 4-in. line, and 0.5 for all sizes greater than 4 in.

Orifices installed according to the recommendations would then, from the curves shown, have a maximum error of coefficient of about 0.25% if the maximum diameter ratio were used, and less for smaller diameter ratios.

Physical Properties in Valve-Body Steel Castings

In rebuilding the Connors Creek power plant for higher pressures and temperatures, Detroit Edison Co. felt it desirable to obtain assurance that the soundness of welding-end valve bodies was such that they could be used safely in the superheated steam and boiler-feed piping. Accordingly, an investigation was carried on, the results of which were reported by A. E. White, C. L. Clark and Sabin Crocker. For the investigation, a number of valve companies provided four carbon-molybdenum cast-steel valve bodies and test lugs to go with them, from which the coupons for tensile, impact and density tests were secured.

Results of the investigation showed that for valve-body castings of the type examined it is possible to obtain: (1) Sound material in the welding ends; (2) properties from welding ends commensurate with those from conventional bars; and (3) castings with reasonably uniform physical properties. These conclusions are stated with due recognition of the fact that the tensile and impact results were not in every case entirely acceptable. However, the results were of such a nature as to lead to the conclusion that after further study with respect to the proper location and size of gates and risers, proper pouring temperature, and determination of the most suitable heat-treatment, sections could be secured from any location which would uniformly meet the given tensile and impact requirements set forth in this paper.

Discussion

That examination of test bars only gives information concerning the metal itself and tells nothing about the condition of the metal in the actual casting, was pointed out by B. T. Malcolm. To make best use of the metal provided by the foundry, the valve must be properly designed so that thin sections merge into heavy sections and the mould must have proper headers, gates and vents. Pilot castings are usually made for new designs and thoroughly examined with x-ray as well as other tests. A satisfactory casting may be made unsatisfactory by improper heat treatment.

SUPERCHARGING AND COSTS FEATURE DIESEL SESSION

Oil & Gas Power Division meeting hears two papers on controversial topics. Dr. Büchi of Switzerland describes his exhaust-gas turbo-blower and Lee Schneitter gives cost figures

Supercharging

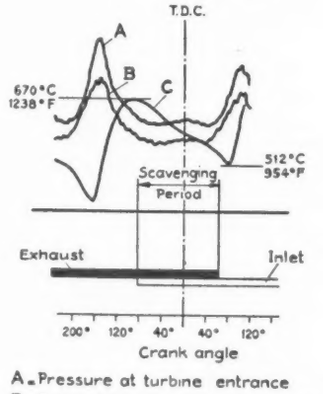
FOR many years, supercharging has been quoted glibly as the eventual solution of weight, cost and space problems with diesels. But cost and mechanical difficulties have always been stumbling blocks. One supercharging method that has been gaining favor steadily is that utilizing an exhaust-gas driven turbo-blower, called after its Swiss discoverer the Büchi system. Dr. Alfred J. Büchi himself presented "Supercharging of Internal-Combustion Engines with Blowers Driven by Exhaust-Gas Turbines," a rare opportunity for Americans to learn more about it.

In the present-day Büchi system, the cylinder is not only charged with compressed air, but is also scavenged with a great quantity of cool combustion air, although the exhaust-gas turbine is placed after the engine and the consequent backpressure in the exhaust. Oscillations in gas pressure to scavenge the cylinders properly are obtained artificially by choosing suitable cross-sections for the turbine and the volume and cross-section of the exhaust-gas piping. Suitable adjustment of the exhaust-valve gear of the engine insures correct occurrence and repetition.

If the working cylinders have to be scavenged, the inlet and outlet valves must be open simultaneously during scavenging. Also, scavenging must not be disturbed by exhaust from another cylinder. If there is disturbance, the gases from the exhausting cylinder will find their way through the open exhaust valves into the cylinder that has to be scavenged. This trouble occurs when all cylinders of an engine exhaust into the same exhaust manifold. It is eliminated in the Büchi system by leading exhaust gases to the turbine through several exhaust pipes, or through exhaust pipes fitted with suitable partitions. Separation of the exhaust pipes is carried down to the admission nozzles at the turbine, so that it is also impossible for the gases to flow back through the turbine.

The number of cylinders exhausting in o one pipe, the time in each cylinder when exhaust begins and stops, and also when admission begins, must be chosen in such a way that no mutually harmful effects may occur. This adjustment must be chosen in various ways to suit the circumstances and the number of cylinders.

Temperature and pressure variations during the exhaust and scavenging period in the exhaust manifold between engine and exhaust-gas turbine of a MAN diesel



A = Pressure at turbine entrance
B = Exhaust pressure past Diesel Engine
C = Exhaust temperature at turbine entrance

Effects of scavenging air are of the utmost importance. These effects are:

1. Freeing the compression space from traces of the hot exhaust gases, in contrast to ordinary internal-combustion engines without supercharging. Cooling the cylinder walls and the valves lowers the initial temperature of the working process and thereby increases considerably the weight of combustion air enclosed in the cylinder.

2. Not only the swept space, but also the compression space, is filled with fresh air suitable for combustion. This makes itself apparent in service in perfect combustion and a great capacity for taking overload.

3. The quantity of heat passing away through the cooling water is less, since a part of the heat given up to the cylinder walls is absorbed direct by the cold scavenging air. However, this heat is not lost, but usefully employed in the turbine. This also explains the high thermal efficiency.

4. Mixing the exhaust gases with the cool scavenging air allows the exhaust-gas turbine to run under favorable conditions; complicated cooling devices for the turbine are rendered unnecessary. Consequently, the loss of heat caused by such cooling is absolutely eliminated.

In general it can be said that the reduction in the dimensions and weights of the engines which is obtained as a result of the increase in output through exhaust-gas turbo-charging, is of course reflected in price of the engines, and in stationary installations it has also the following advantages: For example, the engine building becomes smaller and the foundations can be of lighter construction. As a result of the reduced cooling required, less cooling water has to be provided, thus leading to further savings, especially when water is scarce, and in cases where it is necessary to erect cooling towers. The reduced fuel consumption also plays an important part, especially when the engine is working with variable loads. In four-cycle engines it is also possible to adopt a rational method of utilizing waste heat in the exhaust gases.

The Büchi exhaust turbo-charging can be used also with two-cycle diesels. Tests in connection with this type of engine have already been made and will be continued. Because of the lower temperatures of the exhaust gases, the results obtaind by adopting this system depend greatly on the size and design of the engine in question. However, by adopting special methods of carrying out the charging and scavenging processes, an appreciable increase in output can be obtained.

In addition to the engines previously described which work with liquid fuel, gas engines may also be supercharged by blowers driven by the exhaust gases and some installations have already been made. In order that the cylinder may be scavenged, it is necessary (just as with engines working with gasoline), that the fuel should be admitted only after scavenging.

Discussion

Ralph Miller of Ingersoll-Rand questioned increased pressure in the cylinder due to supercharging, but Dr. Büchi explained that the reduction in temperature obtained by better scavenging more than compensated for this difficulty because it is heat and not pressure that causes most trouble. Dr. Magdeburger announced that the Navy has officially approved supercharging. He quoted these weights: 60 lb. per b.hp. for a 2-cycle engine without supercharger, 65 lb. for a 4-cycle similar engine with supercharger, and 80 lb. for an unsupercharged 4-cycle unit. Dr. Moss felt that Dr. Büchi's work has had a salutary effect in convincing builders of the advantages of higher pressures. Lee Schneitter asked for further cost data, explaining that in one case in which his company had decided to increase engine horsepower of a 3,000-hp. engine to 3,300, the engine was quoted at $20 a hp., or $6,000 for the additional 300 hp. An exhaust-gas driven blowers however would cost $7,000, or installed about $10,000. Dr. Lipetz pointed out that sometimes the question of cost must be subordinated to weight and space requirements, particularly in motive-power units, where heavier prime movers mean heavier construction at high cost. Dr. Lipetz also explained that normally added power from a cylinder means more heat to be disposed of, with consequent troubles from parts, unless some sort of supercharging and scavenging arrangement is used to keep the cylinder cool.

Operation and Maintenance

FEW statistics on diesel-plant operating costs are available in this country. Users rarely keep such data, and even when they do, have no opportunity to correlate them with those on other plants. Lee Schneitter of Ebasco Services Inc. presented such a correlation in "Diesel-Engine Maintenance, Operating and Outage Data." Many of his results are shown in the form of graphs and tables which can be obtained in copies of the original paper.

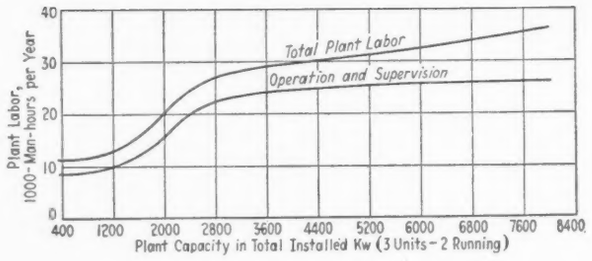
Mr. Schneitter presented a chart showing liner wear plotted against ash content of fuel, in most cases for engines with

cylinders of 16 in. diameter and larger. They show that wear increases rapidly when fuel contains over 0.05% ash, and that during the second half of the normal 16,000-hr. running time it is less than during the first half. These curves indicate that a fuel with 0.03% ash gives liner wear of six to eight years, while with 0.08% ash wear is no greater than two years maximum, figures that have been proved in operation.

Mr. Schneitter charted reduction in capacity due to wear in one 3000-kw. station. Rated at 2800 kw. for safety and economy, the plant actually could carry 2400 kw. when it was decided to change liners. The change brought capacity back to its original figure.

Mr. Schneitter also held that fuel consumption and heat rates given by the maker cannot be maintained by an engine after much wear has occurred.

Mr. Schneitter also gave data on all operating and maintenance costs of 23 plants who report data to Edison Electric Institute. A 3-year average shows that the plants had an average of three units apiece, average rated capacity per plant being 1981 b.hp. Average annual station load factor was 36.9%. Average labor per plant per year was 13,499 man-hours, and average cost of *material* for engine maintenance was $2682, equal to $1.35 per engine b.hp-hr. year. Fifteen plants reported that operating labor was 83% of the total, regular maintenance 13.6%, and extra maintenance labor 3.4%. If the rate is considered as 75 cents per man-hour, total engine maintenance cost becomes $2.20 per year per engine b.hp. Outage for 40 diesel units averaged 9.4% of demand hours—the hours when the unit is required for service. Outages from engine troubles account for 66.4% of total outages, for generators 2.3%, for auxiliaries 2.4%, miscellaneous 0.2%, inspection 28.7%.



Diesel-plant labor in 3-engine plants with two running constantly.

Principal outages for engines were: Inspection and adjustment about 30%, crankshaft 11%, pistons and rings 10%, liners 6.6%, crank and piston-pin bearings 6%, air compressors 5.4%, governors and governor drives 3.1%, cylinder heads 2.9%. Generator outages were very small. In auxiliaries, 32.9% were due to exhaust, 22.8% to water systems, 17.2% to lubrication, 10% to air compressors and 4.6% to fuel-oil equipment. These usually did not affect the engines, however, because duplicate auxiliaries were usually available.

Discussion

Unfortunately, the meeting had already extended well beyond the scheduled time for adjournment, so discussion was of necessity short. Mr. Reed challenged Mr. Schneitter's high maintenance cost figures, showing several examples of typical American plants in which maintenance costs are well below a mill (as in the diesel plants described in the British and American oil power reports). Other discussors also quoted examples, bringing out that much of Mr. Schneitter's data were on engines installed in foreign plants operating in many cases under difficult conditions and poor crews with very poor fuels, and that in many cases the engines were of the early, inefficient types now far out of date.

Commercial Refrigeration and Air Conditioning at A.S.R.E. Meeting

THE American Society of Refrigerating Engineers held its 32nd annual meeting at the Hotel Pennsylvania, New York, N. Y., Dec. 2, 3 and 4. At the technical sessions, air-conditioning problems were given consideration, as well as thermal problems and commercial refrigeration. A full session was devoted to absorption methods of refrigeration applicable to small units. One session was held jointly with the American Society of Mechanical Engineering.

Of the several papers dealing with air-conditioning, those of interest to power engineers included "Air Conditioning Requirements of Modern Multi-Color Offset Printing," by C. G. Weber, "Evaporative Cooling for Comfort," by W. L. Fleisher, and "Review of Existing Phychrometric Data With Relation to Practical Engineering Problems," by W. H. Carrier and C. O. Mackey.

The air-conditioning requirements of modern multi-color offset printing are in some respects peculiar to that process, and are rather difficult to satisfy. It is necessary to control atmospheric conditions, not only for the prevention of distortion, such as curling, waving and buckling of the paper, but to keep the dimensions of the sheet constant during printing (which requires from two to twenty trips through the press). It is shown in the paper that the moisture content of paper in equilibrium may vary by more than 1%, depending on the history of its condition.

Papers conditioned to equilibrium with the press-room air by absorption, then printed in five colors or more, usually gain 0.5% moisture and remain in equilibrium with the same atmospheric humidity. It is essential that this increase in moisture content during printing be avoided to prevent register difficulties.

One method is to adjust the hygrometric condition of the paper to place it on the desorption curve. This may be accomplished by preconditioning in an atmosphere of high relative humidity, then conditioning by desorption to equilibrium with the air. A second method consists of conditioning the original dry paper to equilibrium with a relative humidity 6 to 8% above the press-room.

Walter Fleisher described the general theory of evaporative cooling and the basis on which it may lead to comfortable conditions. He shows in his paper that the highest conditions that can effectively be treated by evaporative cooling is an outside wet bulb of 75 deg. It is indicated that wherever the wet bulb remains consistently below 70 deg., evaporative cooling systems are adequate for complete comfort. A tabulation also shows the number of times the wet bulb has exceeded values from 55 to 95 deg., for 23 principal cities in the United States. With this information the question then becomes to decide whether it is worth while to install mechanical refrigeration for the remaining period when evaporative cooling is not feasible.

The paper also described a new type of humidifier in which the air to be humidified is caused to pass through a unit containing a bundle of thin filaments whose surfaces are wetted with water.

In the field of commercial refrigeration the paper by J. G. Bergdoll discussed requirements of the thermal expansion valves used with Freon-12 refrigerant. He describes the many difficulties had with these valves during their development and the things that were done to correct the difficulties. In closing, the author made a plea to manufacturers to produce valves that (1) have adequate strainers, (2) won't leak at the needle and seat, (3) won't permit loss of refrigerant, (4) won't lose their thermal charge, (5) are not affected by atmospheric moisture, (6) will maintain their superheat setting, (7) won't leak through the external equalizer, (8) have adequate mechanical strength for mounting purposes, (9) are carefully tested and inspected before shipment, (10) are free of pressure cycling, when properly applied, (11) will not permit wet compression under any conditions when set for 10 deg. superheat at full load.

In "Moisture in Insulating Walls," Harvey B. Lindsay reports the results of an investigation to determine something about the mechanism of moisture absorption by insulation.

It was concluded that the humidity in the atmosphere subjected to vapor pressure acts independently of the air, and that it is far more penetrating.

Unless a warm-side covering is given to insulation, capable of holding a partial vacuum indefinitely, water vapor cannot be excluded.

Newly elected officers are H. M. Williams, president; Gardner Poole, vice-president; Geo. E. Hulse, treasurer; L. L. Lewis, H. V. Edwards, L. A. Philipp and H. C. Guild, directors.

New A. S. M. E. Officers

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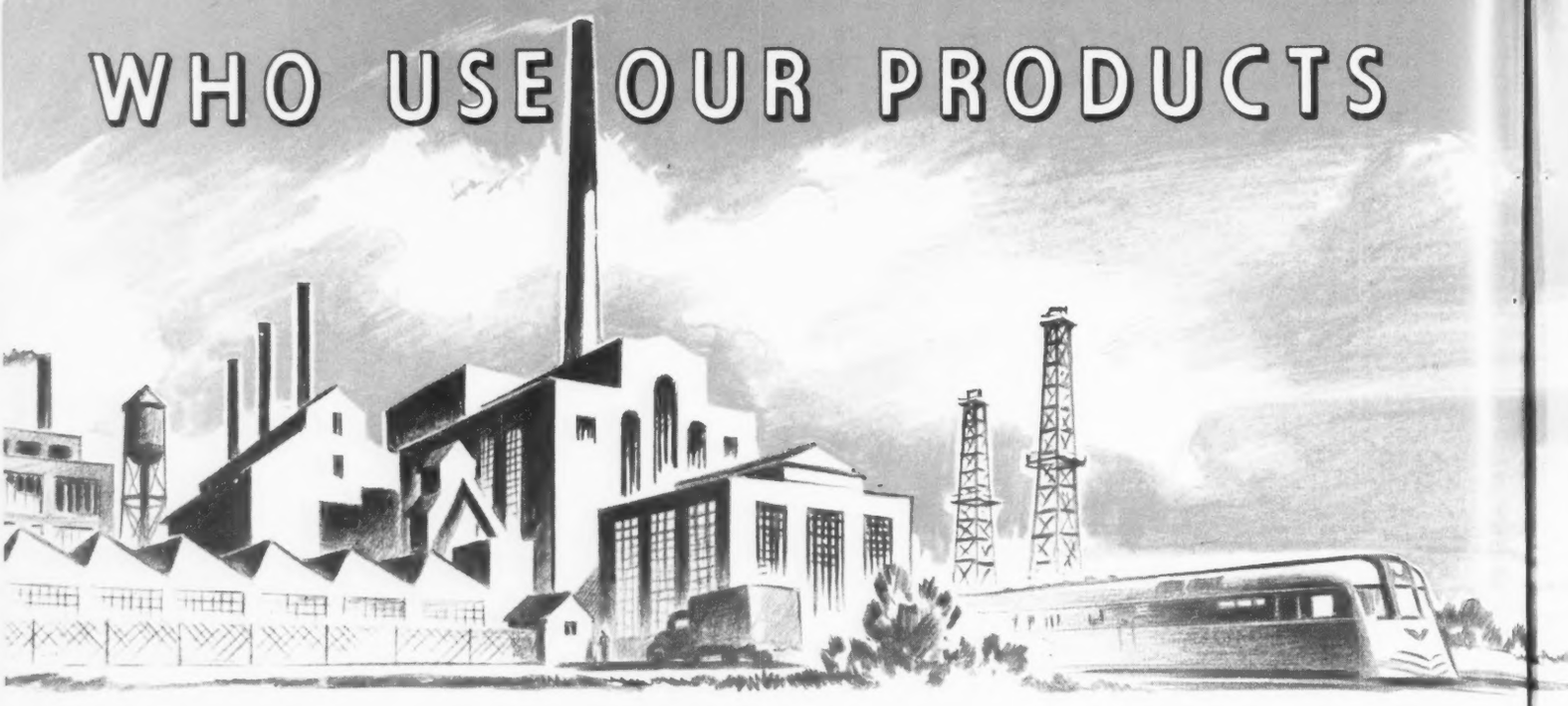
Editor "American Machinist"

E. W. BURBANK
Dallas Manager
Allis-Chalmers Mfg. Co.

THE 1936 ROLL CALL OF WHO USE OUR PRODUCTS



One of the most difficult tasks of the advertiser is to keep his statements regarding his own products wholly unprejudiced. American Hammered publishes this "roll call" of America's major equipment manufacturers —virtually a blue book of American industrial leaders—because the mere mention of their names is perhaps the most eloquent endorsement of our products that could be advanced.

Obviously, the choice of American Hammered Piston Rings as standard equipment on *their* products suggests the rigorous tests to which the designing and engineering staffs of these nationally-known concerns have subjected *our* products. They know better than anyone else could possibly know the requirements of their own equipment. And it is because of the deliberate choice these manufacturers have made that the users of their equipment should be equally mindful of their own interests whenever replacements are necessary. By specifying American Hammered Piston Rings just as the original manufacturer has done, the user really insures his equipment against faulty, expensive performance.

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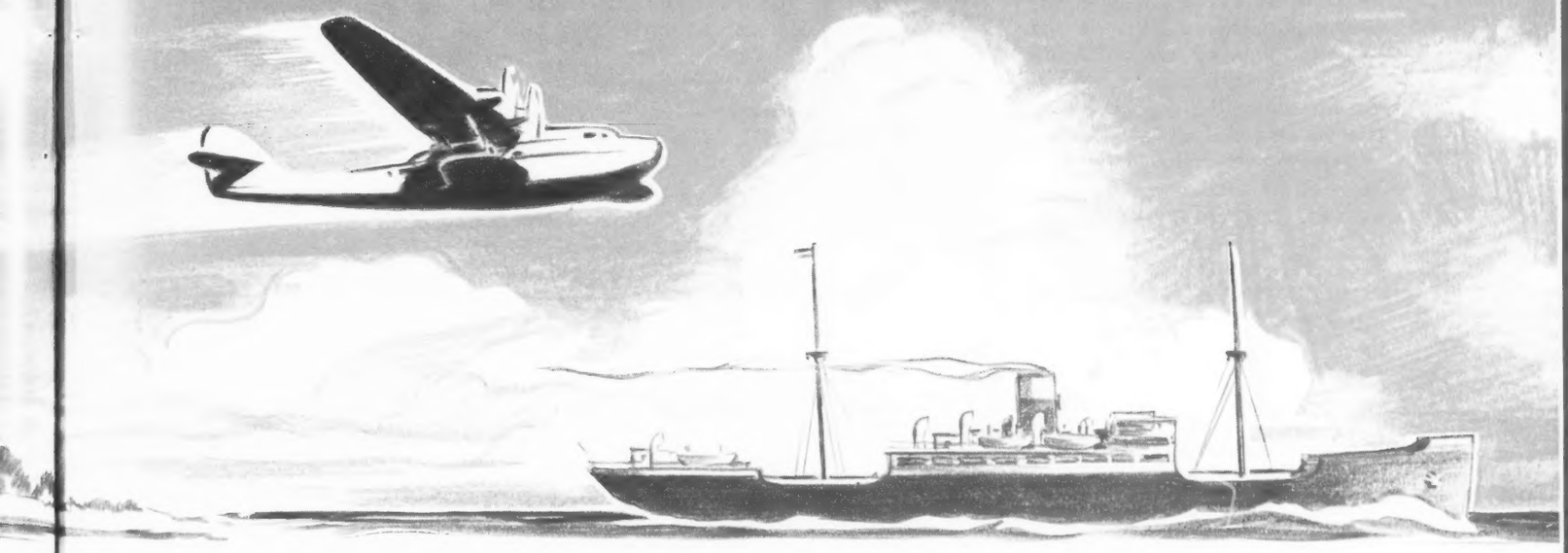
In originally specifying American Hammered Piston Rings, these manufacturers have insured that their own customers may at all times avail themselves of the services of American Hammered field and headquarters engineering staffs. Our specialized engineering knowledge of piston ring application and replacement problems is available to any customer of any one of these great companies.

KOPPERS COMPANY

American Hammered Piston Ring Division, *Baltimore, Maryland*

American Hammered Piston Rings

INDUSTRIAL MANUFACTURERS ☆ AS STANDARD EQUIPMENT



Ajax Iron Works
American Engineering Company
American La France and Foamite Co.
American Locomotive Co.
Ardco Mfg. Co.
Atlas Imperial Diesel Engine Co.
Auto Engine Works
Baldwin Southwark Corporation
Bethlehem Steel Company
Black and Clawson Co.
Bovaird & Seyfang Mfg. Company
Bruce MacBeth Engine Company
Brunner Manufacturing Company
Buda Co.
Buffalo Gasoline Motor Co.
Bury Compressor Co.
Busch Sulzer Bros. Diesel Engine Co.
Carrier Engineering Company
Caterpillar Tractor Company
Champion Pneumatic Machine Co.
Chicago Pneumatic Tool Company
Clark Brothers Company
Continental Aircraft Company
Cooper-Bessemer Corporation
Coshocton Iron Co.
Crane Company
Creamery Package Mfg. Co.
Curtis Manufacturing Company
M. T. Davidson Company
Domestic Engine & Pump Company
Dow Pump and Diesel Engine Co.
E. I. du Pont de Nemours
Eclipse Aviation Corp.
Electric Boat Company
Enterprise Foundry Corp.
Fairbanks, Morse & Company
Foster Pump Works
Foster Engineering Co.
Franklin Valveless Engine Co.
Frick Company
Gardner Denver Company
Gaso Pump & Burner Mfg. Co.
General Electric Company
General Machinery Corp.
Guiberson Diesel Engine Co.
Heisler Locomotive Works
Hooven Owens Rentschler Co.
Hydraulic Press Mfg. Company
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Ingersoll-Rand Company
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Union Switch & Signal Company
United Engineering & Foundry Co.
Universal Cooler Corporation
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Vivian Gas Engine Works
Warner Aircraft Corp.
Westinghouse Electric & Mfg. Co.
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Wolverine Motor Works
Worthington Pump & Mach. Corp.
Wright Aeronautical Corp.
York Ice Machinery Corporation

☆ *Exclusive of Automotive Industry*

American Hammered Piston Rings

Stepping Out

Engineering and Human Highlights of A.S.M.E. Meeting

PARTICULARLY in a Power Show year, the annual A.S.M.E. meeting in New York is an event to be remembered long for floods of new ideas, personal contacts, brilliant events and tired feet. This, the first since the depression—for it apparently has passed—sparkled with life. As always, old engineering cronies stopped to chat between sessions in the lobby of the Engineering Societies Building, 29 West 39th St. During the week most of the visitors found their way to the National Power Show—best power display in the Grand Central Palace since 1928.

Parallel societies held meetings of interest to many A.S.M.E. members. Personnel and management groups and the A.S.R.E. held forth at the Hotel Pennsylvania. The Society for the Promotion of Engineering Education met at Columbia University. Alumni of ten engineering schools held reunions at lunch or dinner. Inspection groups visited Rockefeller Center, the "Queen Mary," Hunts Point Gas plant, Stevens Institute, Pennsylvania R.R. terminal, American Sugar Refinery (Brooklyn), Hayden Planetarium, Ford Motor Co. (Edgewater, N. J.), Jacob Ruppert Brewing Co.

As always, the ladies, patient wives of hard-working engineers, had their fling in a round of lunches, dinners, teas and flossy inspection trips.

Westinghouse Honored

Honors night brought recognition of engineering work well done—honorary membership to Geo. A. Orrok for outstanding contributions in the power field—A.S.M.E. Medal to Edward Bausch for engineering developments in optics—the Worcester Reed Warner Medal to Prof. Chas. M. Allen of Worcester Tech. for his work in hydraulics—the Melville Medal to H. A. Stevens Howarth—the Junior Award to Harwood F. Mullikin, Jr.—the undergraduate award to Leon B. Stinson.

In the same session Yale's president, James Rowland Angell, as 1936 Towne lecturer, eulogized the achievements of George Westinghouse.

Ninetieth birthdays of two great engineers, one living and one dead, were celebrated in various A. S.M.E. sessions. George Westinghouse was brought out of the past by President Angell and also by a group of distinguished engineers who told of his personality and works in a special afternoon session. Ambrose Swasey graced his own birthday celebration at the annual dinner.

Swasey Gets Medal

This Annual Dinner crowding the great banquet hall of the Hotel Astor, was a complete success. On the platform were many distinguished engineers, including an Ex-President of the United States. In the center of them all, the object of veneration by engineers everywhere, sat the white-haired Ambrose Swasey, with a mind still keen and personality still radiant. The dinner was dedicated to him, and to him was awarded the Hoover Gold Medal. Presentation was made by Gano Dunn.

Ex-President Hoover, in his brief speech, praised the accomplishments of Swasey, a Yankee mechanic transplanted in Cleveland, Ohio. He said that many of today's problems arise from the work of engineers and that engineers must help to solve them. Machines do not reduce the need for labor provided the economies produced are passed along to consumers in lower prices. Failure to pass along these savings, he said, was a primary cause of the last depression.

Other features of the meeting were the Thurston Lecture, whimsically presented by Dr. Harlow Shapley, director of Harvard's Observatory, and the reception for James H. Herron, president elect. William L. Batt, retiring president, acted as toastmaster. Mr. Herron is president of James H. Herron Co., Cleveland, also an author and inventor.

Diesel Lionized

Tuesday noon, at the Waldorf-Astoria, the Diesel Committee put on one of the most elaborate luncheons of recent years in honor of Dr. Rudolf Diesel and his introduction of diesel power into the United States 40 years ago. A distinguished group of 300 leaders in business, industry and engineering gathered for the luncheon and the program, broadcast over a nationwide hookup with John B. Kennedy as master of ceremonies. Mr. Kennedy, who had just completed a 10,000-mile trip in which he saw all types of diesels, visited manufacturers and installations, compared the first 400-lb.-per-hp. diesel with the 13-lb.-per-hp. automotive units of today.

The radio broadcast, conducted by Gordon Rentschler, president of the National City Bank of N. Y., who is chairman of the Diesel Committee, included such noted speakers as E. B. Pollister, president of Busch-Sulzer; Col. Robert H. Morse, president of Fairbanks-Morse; B. C. Heacock, president of Caterpillar Tractor Co.; C. L. Cummins, president of Cummins Engine Co.; David Sarnoff, president of RCA; C. F. Kettering, vice-president in charge of research for General Motors; Thomas H. Beck, president Crowell Publishing Co.; E. G. Budd, president of the Edward G. Budd Mfg. Co.; Capt E. F. Rickenbacker, vice-president Eastern Air Lines; and Prof. R. U. Blasingame, president of the American Society of Agricultural Engineers. Other members of the Diesel Committee included Arthur Brisbane; H. L. Hamilton, president of Electromotive Corp.; Malcolm Muir, president of McGraw-Hill Publishing Co.; Walter C. Teagle, president Standard Oil Co. of N. J.; C. A. Criqui Sr., president of Sterling Engine Co.; B. F. Fairless, president Carnegie-Illinois Steel Corp.; and Frank A. Vanderlip Sr.

All in all, the meeting was an amazing example of the growth in popularity of the diesel and the increasing public interest in its development.

Review of

POWER and MECHANICAL EQUIPMENT

In the pages that follow **Power** presents its ninth annual review of new and improved equipment. The 340 descriptions here presented are summaries of those which have appeared in **Power** since January, 1936, supplemented by about 10 items not described during the year but received on our special request to make this review complete.

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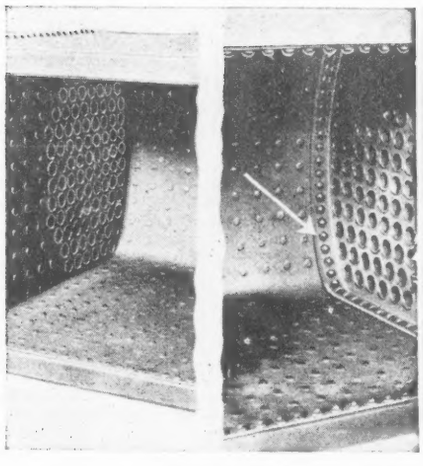
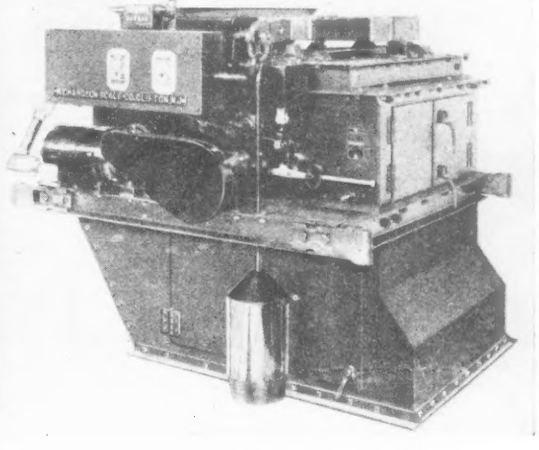
BOILERS, REFRACTORIES AND ACCESSORIES





LOCOMOTIVE-TYPE PORTABLE BOILER

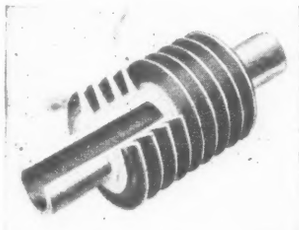
LUCEY, 84-in., oil-country boiler has no riveted seams in firebox. 1,000 and 1,250 sq. ft., 250 and 300 lb. pressures.—*Lucey Boiler & Mfg. Corp., Chattanooga, Tenn.*

TUBE CLEANER

"SENIOR", designed for quicker removal of extremely tough scale, has larger air passages and eliminates backpressure in operating range, giving greater speed and power. Quickly adjustable 3-stage volume control. 2-part "Rotocentric" motor with single fiber blade. Bulletin.—*Roto Co., 142 Sussex Ave., Newark, N. J.*

EXTENDED-SURFACE ECONOMIZER

TYPE EX, manufactured under Foster-Wheeler patents, is a 2-in. steel



tube on outside of which are shrunk a series of cast-iron gilled rings bored to insure perfect metal-to-metal contact on tubes. Ring castings are male and female joints so that fins only are exposed to furnace gas, while steel tubes resist water pressure. Elements straight, thus easily cleaned. All pressure joints outside, thus water may be drained from economizer without shutting down boiler. Compact, immune from corrosion, and allows expansion.—*Green Fuel Economizer Co., Inc., Beacon, N. Y.*

AUTOMATIC COAL SCALES FOR SMALL BOILERS

50-LB. and 100-lb. unit or hopper-capacity sizes, weighing coal to stokers or pulverizers. 6-figure mechanical rustproof and dustproof counter. 2 models—stationary with brackets, and portable with wheels for moving aside to clean boiler tubes. Two types—open for weighing to stokers, and inclosed for weighing to pulverizers. Weighs coal up to 2 in. in size. 50-lb. unit has hourly rating of 2 to 3 tons; 100-lb. unit hourly rating of 4 to 6 tons. Bulletin 2236.—*Richardson Scale Co., Clifton, N. J.*

FLEXIBLE FIREBRICK WALL CONSTRUCTION

"ROBINSON" joints consist of box-like casings in which refractory bricks are encased. Claimed to overcome pinching, spalling and checking, as well as cracking and bulging of walls. Structure laid up dry without high-temperature cements or fireclays. Joint material is chemically treated asbestos, providing usual 3/16-in. expansion allowance per foot, although this can be varied to suit.—*Continental Eng. Co., Inc., 64 Hamilton St., Paterson, N. J.*

BOILER-TUBE EMERGENCY PLUGS

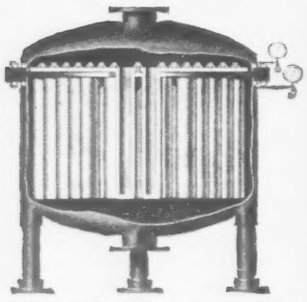
"MADE-RITE" emergency plug has been tested at pressures to 1,800 lb. per sq. in. Consists of center tapered pin ending in threaded section. Over this slips, in order, a 3-part expanding washer normally held shut by a circular spring, metal washer, asbestos composition washer, another thick metal washer, and tightening nut. Assembly is placed in tube end, then nut is tightened with small hand wrench. To handle leaks between tube and sheet, asbestos washer is replaced with another steel one and unit placed in tube only far enough so that expanding washer spreads tube as necessary. Easily removed and can be used again. Similar unit, for marine boilers, has long bolt, turned by socket wrench for sealing far end of tube from front header. — *Wainwright-Hardie, 1245 Madison Ave., New York, N. Y.*

PLASTIC INSULATION

ADA-STIC, for up to 2,000 deg. F., can be applied by hand, trowel or Botfield cement-spraying equipment. Adheres firmly to clean surface, and stands up under hard usage. Circular.—*Botfield Refractories Co., Swanson & Clymer Sts., Philadelphia, Pa.*

FEEDWATER FILTER

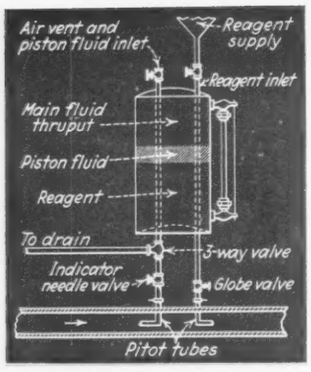
MULTIPLE arrangement of porous filter tubes suspended from tube sheets



within steel shells. Water enters through bottom, passes through walls of tubes and emerges through top nozzle. Chemical feed consists of 3-gal. cast-iron alum container, sight-feed valve and proportionate differential feed.—*R. P. Adams Co., 220 Delaware Ave., Buffalo, N. Y.*

FEEDWATER HEATER

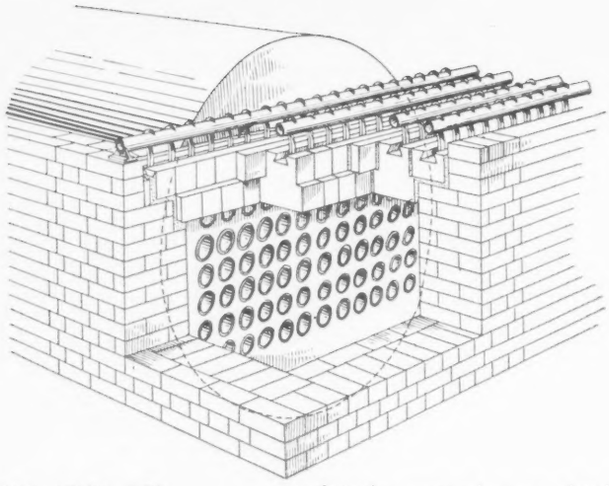
NON-DEAERATING, stationary heater uses exhaust steam to heat water within 2 deg. of saturation temperature. Multibaffle separators to eliminate oil and two-pass filter to remove solid matter. Bulletin W-210-B19.—*Worthington Pump & Machinery Corp., Harrison, N. J.*



liquid line. Booklet.—*D. W. Haering & Co., Inc., 3408 Monroe St., Chicago, Ill.*

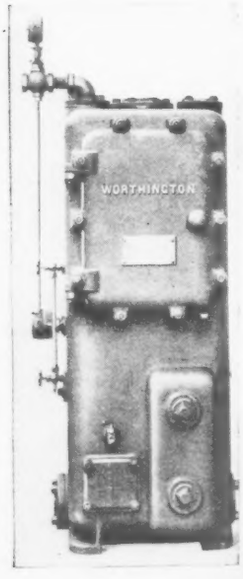
SUPPORTED FURNACE WALL

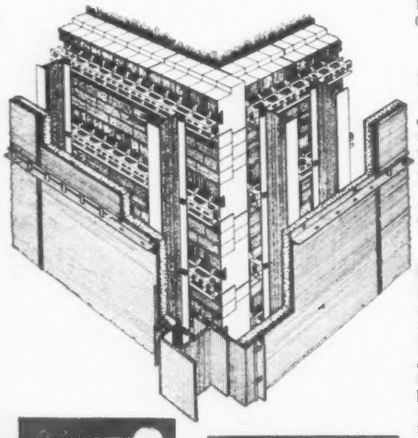
SECTIONALIZED wall, each section independent. Weight of all refractories transferred to supporting steel framework. Joints broken to prevent infiltration of air. Refractory belt spacing can be varied simply by increasing or decreasing number of courses of standard firebrick.—*Geo. P. Reintjes Co., 2517 Jefferson St., Kansas City, Mo.*



REAR ARCH FOR H.R.T. BOILERS

STANDARD wall tiles used as rear arches. Each tile individually hung by independent casting from pipe. Infiltration of excess air is prevented by placing standard 9-in. firebrick between each pair of tiles. Flat suspended arch provides turbulence.—*Geo. P. Reintjes Co., Kansas City, Mo.*



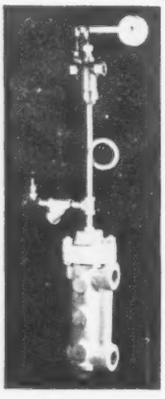


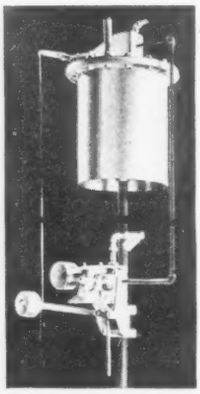
SLAG DESTROYER

"OXI," dry crystalline composition creates oxygen when thrown into furnace; said to burn combustible matter in soot, carbon scale and slag. For water- and fire-tube boilers. 1 lb. for 250 sq. ft. per day.—*Walters Mfg. Co., Inc., 51 East 42nd St., New York, N. Y*

DIRECT-PRESSURE BOILER FEEDER (*Left*)

MIDGET unit brings return-trap practice to boilers up to 100 sq. ft. Remote control at tank is independent of valve mechanism, thus may be placed above boiler while controlling device remains within easy reach. Unit handles both condensation and make-up water.—*Morehead Mfg. Co., Detroit, Mich.*



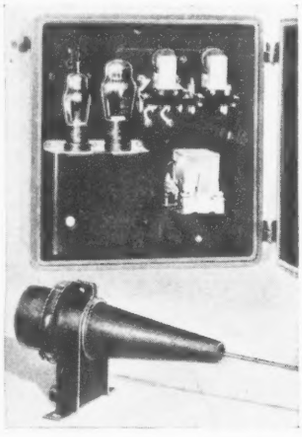


MAKE-UP WATER CONTROL (*Far Left*)

FOR use with Morehead systems, automatically provides make-up water. May be installed with any back-to-boiler system.—*Morehead Mfg. Co., Detroit, Mich.*

BOILER-WATER LEVEL CONTROL

FOR boilers up to 1,000 sq. ft. with pressures of 20 to 150 lb. Electrode holder mounted on water column in connection with gage glass. Electrode holder has adjustable long and short electrodes connected to an electric relay. When water level drops below long electrode, relay opens electric valve until water rises to level of shorter electrode, when current is cut off. No floats, stuffing boxes, generators or thermostats. Circular.—*Johnson Corp., Three Rivers, Mich.*



COMBUSTION SAFEGUARD

Two types of relays and a flame-sensitive electrode. Thermionic tubes for rectification and amplification of power input which, when conducted from electrode input to ground, through flame, operates relay, controlling operation and sequence of main fuel valve, etc. For front of board for flush mounting. Uses standard radio tubes.—*Brown Instrument Co., Division of Minneapolis-Honeywell Regulator Co., 4490 Wayne Ave., Philadelphia, Pa.*

CORROSIVE-SOLUTION FEEDER

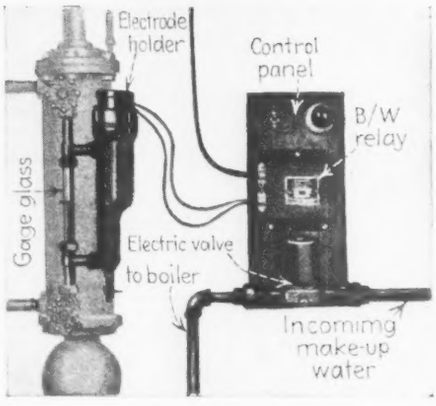
MODEL "E" feeds hypochlorite, sulphuric acid and ferric chloride into

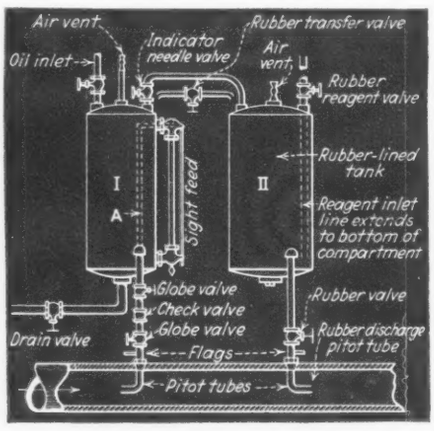
WATER-REGULATED SUPERHEATER

GIVES desired superheat at any boiler rating, delivers steam at specified temperature regardless of operating variations in CO_2 and soot accumulation, can be designed for low pressure drop even though in furnace, and performance can be accurately predetermined. Illustrated is a cross-section of superheater element, in which outer tubes are steam conductors and inner tubes carry temperature-controlling water.—*Controlled Heat Equip. Co., Dime Bank Bldg., Detroit.*

SOLUTION FEEDER

MODEL "A" low-priced feeder uses chemically inert fluid heavier than main fluid and lighter than reagent as piston. Flow pushes reagent into

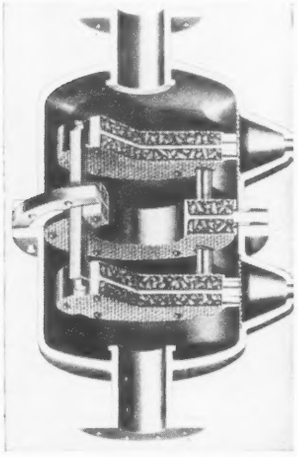


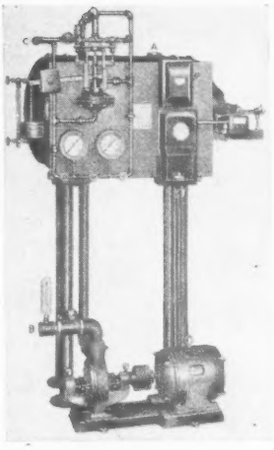


liquid lines for water treatment. Inlet line (A). Flow pressure causes oil to go from I to II, forcing reagent out of rubber-lined II into liquid line. Booklet.—*D. W. Haering & Co., Inc., 3408 Monroe St., Chicago.*

PURIFIER AND DRIER

"EXHAUSTEAM" subjects vapor to sudden reduction in velocity, sudden deflection by baffling, centrifugal force and capillary action.—*Morehead Mfg. Co., Detroit, Mich.*

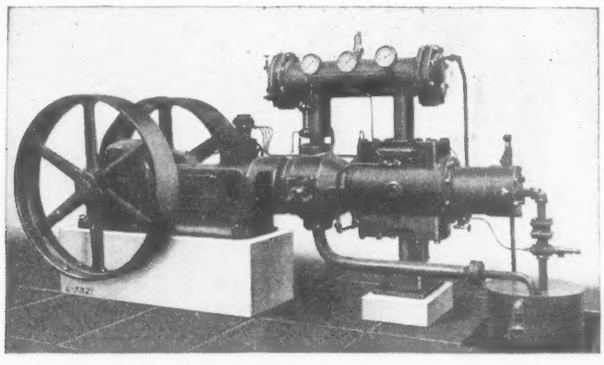




BOILER-RETURN SYSTEM

CLOSED-TYPE pumping system returns condensate at above 300 deg. F. Claimed to save 15% over trap systems and to cut pressure differentials, thus saving wear and tear on system. Consists of return tank and steam pump with necessary gages and valves for automatic operation. A—Return line from steam traps; B—Feed line to boiler; C—Initial pressure to steam units. Bulletin No. 50.—*Stickle Steam Specialties Co., Indianapolis, Ind.*

BLOWERS, FANS, COMPRESSORS



3-STAGE COMPRESSOR

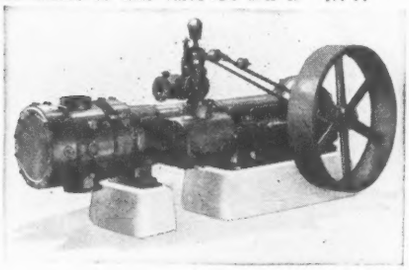
SINGLE horizontal compressors for pressures of 750 to 2,500 lb. Compression cylinder requires only one packing box subjected only to moderate pressure. For high compression of air, oxygen, hydrogen, helium, special gases, refinery gas or straight natural gas. Roller bearing, automatic self-oiling frames with oil-tight covers, feather and ring-plate valves and inter-cooling between stages. Steam or motor drive. Bulletin L-611-B12.—*Worthington Pump and Machinery Corp., Harrison, N. J.*

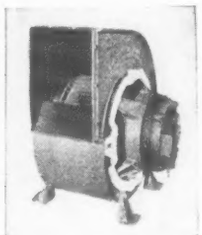
STEAM-DRIVEN COMPRESSOR

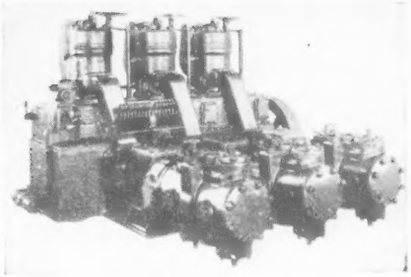
SINGLE-STAGE, horizontal, Class WA-7, for steam pressures of 80 to 250 lb., air pressures up to 160 lb., 279 to 1987 c.f.m. Steam cylinder heavily lagged. Balanced-piston steam valve with inlet pressure in the middle so that valve-rod box is sealed against exhaust only. Various controls: throttling flyball governor, fly-wheel governor, etc. Roller bearings, force-feed lubrication, alloy air-cylinder liner, laminated cushion-back valves. Bulletin A-14.—*Sullivan Machinery Co., Michigan City, Ind.*

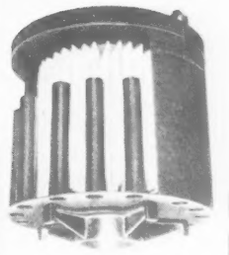
COMPRESSORS

COMPACT, self-contained, 3- and 6-cyl., vertical-angle, 2-stage, air-cooled. Capacities 142 to 445 c.f.m. 3-cyl. unit has two low-pressure cylinders opposite each other at an angle, with a high-pressure cylinder set vertically between. 6-cyl. unit is set in same manner, with two cylinders side by side in each position. Multi-V-Drive, direct-connection to motor through flexible coupling, or motor mounted directly on crankshaft end. Force-feed lubrication. Oil cooler and filter. Bulletin L-620-B16. — *Worthington Pump & Machinery Corp., Harrison, N. J.*







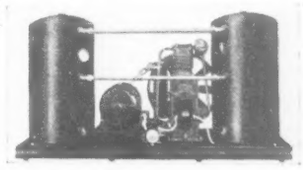


I. C. ENGINE-COMPRESSOR

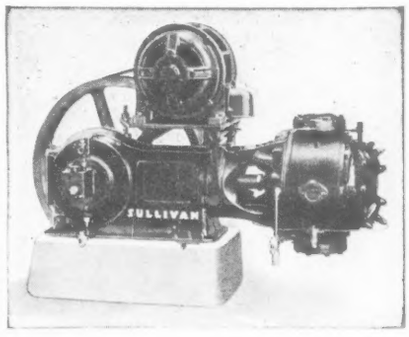
BY COMBINING vertical gas or diesel cylinders with horizontal compressor cylinders at a right angle, this unit reduces floor space, foundation and shipping costs. Gas engine is 2-cycle operating on Clark principle of injecting fuel under pressure after cylinder has been scavenged with pure air and exhaust ports have closed. Scavenging air provided by compressor piston incorporated in crosshead of main compressor shaft. Also built with cylinder 1 in. smaller in diameter for conversion to diesel. 2, 3 and 4 power cylinders, with corresponding number of compressor cylinders, and rated 200, 300 and 400 hp. Compressor cylinders for discharge pressure from 50 to 3,000 lb.—*Clark Bros. Co., Olean, N. Y.*

SILENCER-FILTER

"PROTECTOMOTOR," for air compressors, filters incoming air and muffles "thump." Circular fin construction combined with positive dry filtering medium.—*Staynew Filter Corp., 25 Leighton Ave., Rochester, N. Y.*



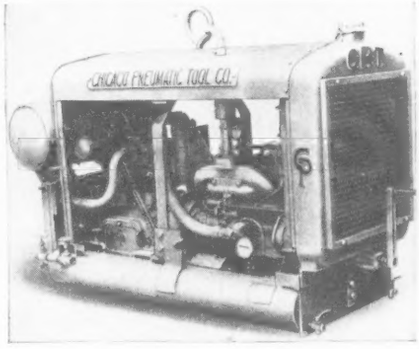
AIR COMPRESSORS



BALANCED, anhydrous, 1 to 125 c.f.m. at pressures of 10 to 400 lb. Claimed to deliver oil- and moisture- free air at high efficiency. Cork-insulated, steel machine base, ball-bearing motor and compressor. Catalog.—*Union-C Machine Co., Union City, N. J.*

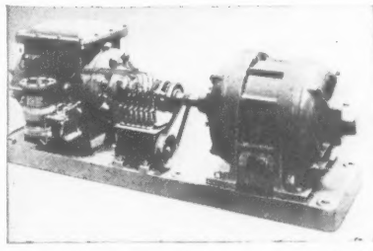
AIR COMPRESSOR

STATIONARY, WG-8, heavy-duty, single-stage, 1-cyl., double-acting, horizontal air and gas compressor in sizes 10 to 50 hp. and pressures of 5 to 150 lb. Bulletin A-13. — *Sullivan Machinery Co., Michigan City, Ind.*



AIR COMPRESSOR

SELF-CONTAINED, air-cooled, gasoline engine-driven compressor. Direct-connected to 4-cyl., 900 r.p.m., Hercules engine to produce 85 c.f.m. at 100-lb. pressure, 7¼ in. long, 30 in. wide and 50 in. high. Bulletin.—*Chicago Pneumatic Tool Co., 6 East 44th St., New York, N. Y.*



AIR COMPRESSOR

"RO-TWIN" sliding-vane, 2-stage rotary compressor for pressures up to 100 lb. has both stages and inter-cooler in single casing. One stuffing box, one flexible coupling and two bearings. From 20 hp., 1740 r.p.m. to 100 hp., 690 r.p.m. for from 69 to 412 c.f.m. at 100 lb. pressure.—*Allis-Chalmers Mfg. Co., Milwaukee, Wis.*

DRIVE BRACKET FOR BLOWER *(Left)*

QUIET. Standard motor bracket is mounted on second floating bracket insulated from blower housing, to which it is secured by flexible rubber cushions. Floating drive bracket shown on photograph by white finish. No metal-to-metal contact. Used on Hg Type B or Type BC direct-connected universal blowers.—*Hg Electric Ventilating Co., 2850 North Crawford Ave., Chicago, Ill.*

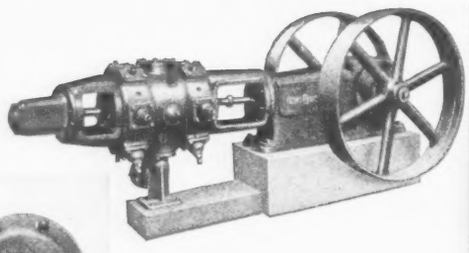
AIR HOSE

"STERLING" cord air hose built like tire with cords laid in tough rubber cushions and isolated from adjacent plies. Lighter, more flexible, and greater resistance to pressure. Special compounded cover. Oil resistant rubber in tube.—*New York Belting & Packing Co., Passaic, N. J.*

AIR-LINE CONDENSER

TYPE HP-504-2 heavy-duty condenser removes oil and water from air lines

by battle arrangement and pair of filter pads. Maximum air delivery volume of 75 cu. ft. or less.—*DeVilbiss Co., Toledo, Ohio.*

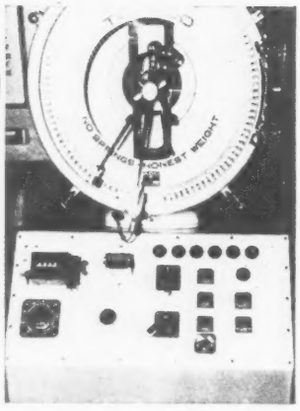


AIR REGULATOR

TYPE HFS for sensitive regulation below 30 lb. Variation 1 oz. for each 10-lb variation of main-line pressure.—*DeVilbiss Co., Toledo, Ohio.*

AIR COMPRESSOR

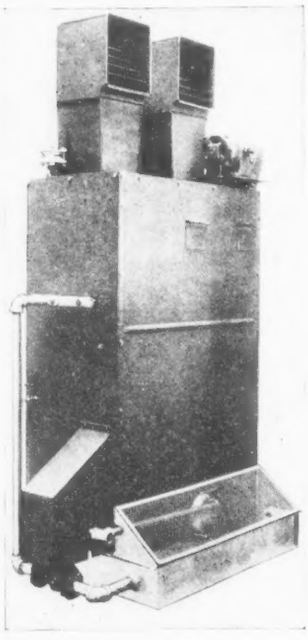
CARBON packing ring so that no grease or oil is required for lubricating air cylinder of "Oilfreair," Class 3-ATC compressor. Tail rod and bearing carry weight of piston to preserve carbon ring. Collar on piston rod keeps oil out of cylinder. Flat or multiple V-belt drive, or direct-connected synchronous motor, steam engine or countershaft.—*Pennsylvania Pump & Compressor Co., Easton, Pa.*



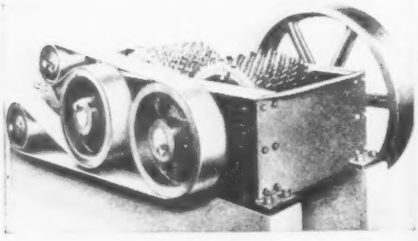
WEIGHING MACHINE

COMPLETE remote control, indication and recording of weighing process is provided by this automatic system. Dial or lever system actuates remote-indicating dial and totalizing device for each boiler. Drop in coal supply indicated on remote dial and automatically reduces air supply in proportion.—*Toledo* (Ohio) *Scale Co.*

accordance with load. Actuated by special electric motor.—*Hoffman Specialty Co., Waterbury, Conn.*

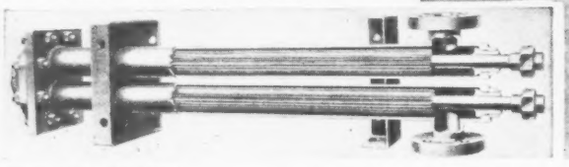


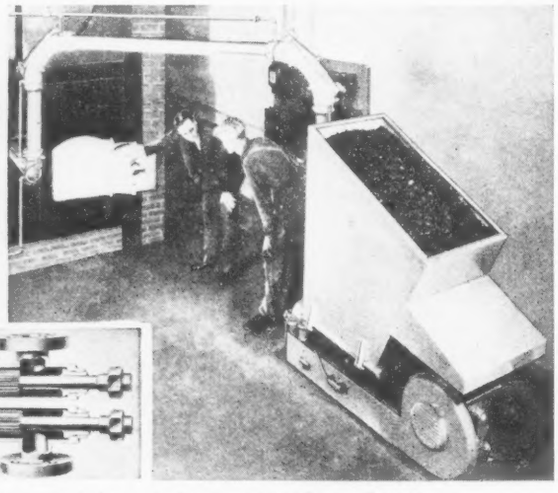
FUEL-BURNING EQUIPMENT



Above—Jeffrey coal crusher

Below—Griscom-Russell fuel oil heater





FUEL-OIL HEATER

TWIN G-Fin section heater has exterior heating surface more than eight times area of interior cylindrical surface. Two parallel steel pipes with flanged inlet and outlet connections at one end and welded flange at other serve as shells for fin-pipes. 18 longitudinal fins about circumference extend along length of each pipe from shell connection to return bend at floating end where steel ring around fins supports internal pipe in shell.—*Griscom-Russell Co., 285 Madison Ave., New York, N. Y.*

COAL CRUSHER

SELF-CONTAINED, endless belt drive between rolls of this double-roll crusher allow quick adjustment of rolls within limits of sizing range while machine is running. All-steel frame with heavy steel cross-ties.—*Jeffrey Mfg. Co., Columbus, Ohio.*

SPREADER STOKER

FEED worm measures up to 1½-in. coal and conveys it into transfer box, where it is picked up by air stream and carried to spreader nozzles. Finer particles burned in suspension. Larger pieces spread in shallow layer. Temperature at grate line is below fusion point of ash and clinkers. Five sizes, 75 to 500 b.h.p.—*Iron Fireman Mfg. Co.,* 1305 *S. W. 12th Ave., Portland, Ore.*

ECONOMIZER FOR AIR-CONDITIONING

TO REDUCE water consumption, a combination forced-draft cooling-tower and refrigerant condenser, indoor or outdoor. Fan passes outside air through pipe coils over which water trickles. Refrigerant condensed inside coils falls to liquid receiver in base. Cooling water recirculated from drain pan by pump driven by 1/6-hp. motor. Make-up automatically by float valve. Seamless-steel liquid-receiver with dished-head is provided with vortex eliminator to insure minimum liquid level and maintain liquid seal. Standard capacities 3 to 50 tons.—*York Ice Machinery Corp., York, Pa.*

ELECTRIC UNIT HEATER

"ELECTROMODE" convection heater takes ¾ kw. Calrod element around which aluminum is poured. 4½ in. wide, 9½ in. long and 16 in. high, completely insulated, flush with wall. —*Electric Air Heater Co., Division of American Founders Eqpt. Co.,* 555 *Byrkit St., Mishawaka, Ind.*

AIR-CONDITIONER

REDESIGNED "Climate Changer" has coated cascade traps and target-type humidifier which eliminates clogging of spray nozzles. ½-in. thick insulation on bottom of unit prevents sweating. Motor now on side for easy servicing.—*Trane Co., La Crosse, Wis.*

HEATING, VENTILATING, REFRIGERATING

UNIT COOLER

UNIT, suspended in room, is equipped with motor and fan. No duct work. Rotated in full circle by loosening locknut and two unions. Coolant may be tap or well water, ice or refrigerated water, alcohol, glycerin or other non-corrosive brine. For heating, hot water or low-pressure steam can be circulated.—*Modine Mfg. Co., Racine, Wis.*

REFRIGERANT GAS LEAK DETECTOR

"PREST-O-LITE Halide Leak Detector" for refrigerating and air conditioning units using chemical compounds containing halogen family—fluorine, chlorine, bromine, iodine. Needle-valve torch-handle assembly, burner which includes suction nipple for attaching rubber hose, and chimney with copper reaction plate. Not suitable for locating leaks of any combustible gas.—*Linde Air Products Co., 30 East 42nd St., New York, N. Y.*

UNIT HEATERS

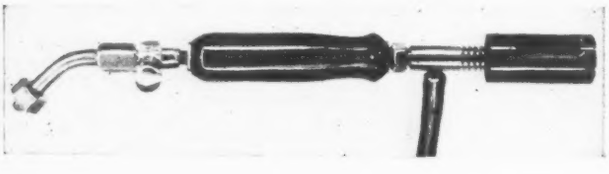
"AIRVECTOR" has new motor mounting and vibration-deadening ribs, welded construction. Full range of sizes. Catalog C-4.—*Airtherm Mfg. Co.,* 1474 *S. Vandeventer, St. Louis, Mo.*

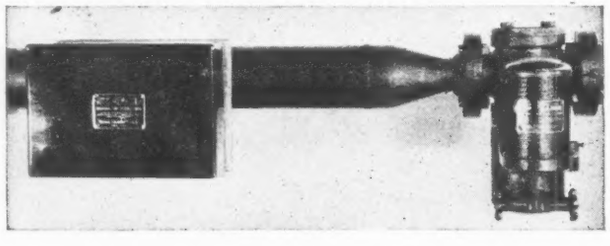
ZONE CONTROL HEATING SYSTEM

TYPE G pressure box for remote control regulates motor movement in Type AS or AL damper motors, **Type B or C modulating zone valves. Installed on low-pressure heating** steam main or riser leading to radiator orifices. Modulating zone valve, to right of pressure box, reduces steam supply from pressures over 100 lb. to fraction of an ounce for lower rates of flow through radiator orifices. Also regulates supply in

GLASS-WOOL INSULATION

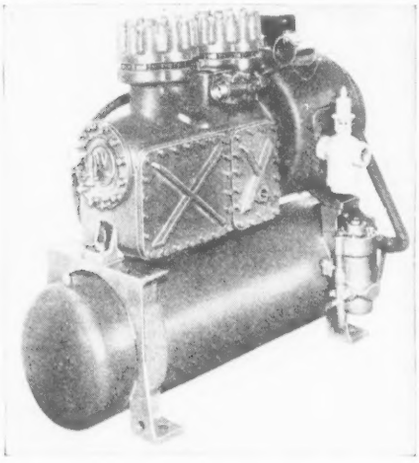
LONG, interlocked glass fibers, for refrigerated and heated equipment up to 1,000 deg. F. Variety of forms in densities from 1½ lb. to 6 lb. per cu. ft. Highly efficient insulator, will not absorb fumes or moisture, fireproof, sterile, rotproof and chemically stable; fluffs and expands instead of settling.—*Armstrong Cork Products Co., Lancaster, Pa.*





CONDENSING UNITS

TYPE "CLS", hermetically sealed, rated at from 7 to 22 tons cooling capacity, have water-cooled a.c. motors completely inclosed with compressors and use Freon as refrigerant. Rotor of driving motor is overhung from main rear compressor bearing on short extension of compressor crankshaft. Forced lubrication from pump driven from main crankshaft through Micarta gear. Series-parallel condenser manifold permits use of city water or cooling tower.—*Westinghouse Electric & Mfg. Co., Mansfield, Ohio.*



CONDENSING UNIT

TYPE CM-122L combines belt-driven compressor, external motor, V-belt, shell-and-tube condenser-receiver, liquid refrigerant strainer, suction-pressure controller, high-pressure safety lockout, water-regulating valve, service valves, water and refrigerant connections, lubricating oil charge, and holding charge of Freon refrigerant on one base. 40-hp. motor, a.c. or d.c., and provides cooling of 514,000 B.t.u. per hr., with cooling water at 75 deg. F., and water consumption of 3,880 g.h.p. Compressor V-8 type, 4x4 in., operating at 650 r.p.m.—*General Electric Co., Schenectady, N. Y.*

GLASS FILTERS

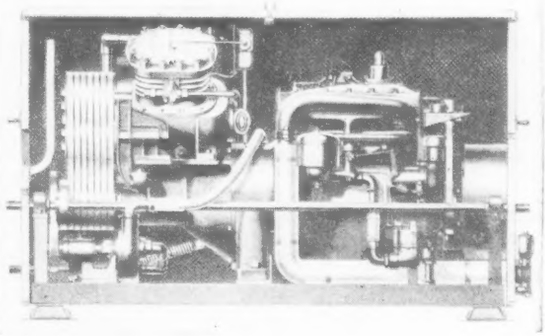
AIR filters consist of series of bonded mats and flexible glass fibers confined on intake and discharge faces by expanded metal grilles and inclosed by fibre-board frame. Mass of glass fibres coated with odorless, fireproof, non-evaporating and non-corrosive chemical, physically catch and hold all manner of dust particles. Will gather four times its own weight of 2 lb.—*Industrial Market Division, Owens-Illinois Glass Co., Toledo.*

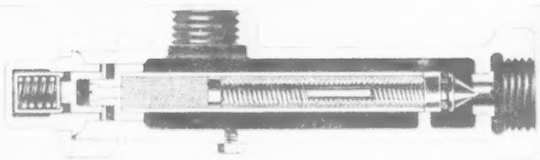
UNIT HEATERS

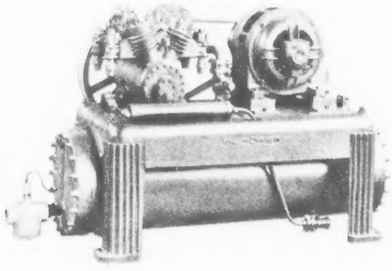
MODEL 6280 direct-suspension unit has capacity at 2 lb. steam and 60-deg. entering air of 148,800 B.t.u. per hr., and replaces 620 sq. ft. of cast-iron radiation at standard conditions. Single, 2- or 3-speed motors. Model 1300 is a large single-condenser, single-fan unit with side tappings to save headroom. Capacity is 312,000 B.t.u. per hour at 2-lb. steam and 60-deg. entering air. Replaces 1,300 sq. ft. of cast-iron radiation at standard conditions.—*Modine Mfg. Co., Racine, Wis.*

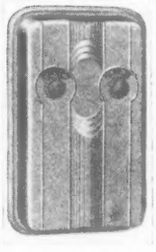
ENGINE-DRIVEN REFRIGERATING UNIT

"ICE ENGINE" operates on artificial or natural gas. Fully automatic. Seven tons ice-melting effect. Single or multiple units. Mechanism inclosed in sound-silenced cabinets, cushion-mounted. Powered by Model FC heavy-duty, 4-cyl., 3½x4-in., 20-hp., 1,160-r.p.m., gas or gasoline engine. Battery started and ignited. Automatic thermostatic ventilating water-cooled, closed-in sound-silenced cabinet, pressure lubricated with oil filter, automatic vacuum-operated clutch. Compressor is 4-cyl., V-type, 3½x2½-in., 600-r.p.m. unit. Driven by multiple V-belt with automatic tightener. Arranged for shell-and-tube (running water) or evaporative condenser. High and low-pressure cutout automatic control. Freon or methyl chloride as refrigerants. Low-side refrigerant line, 1⅛ in. O.D. high-side, ⅞ in. O. D. to condenser. Over-all size of unit 66 in. long, 27 in. wide, 35 in. high. Weight, 1,000 lb.—*Waukesha Motor Co., Waukesha, Wis.*







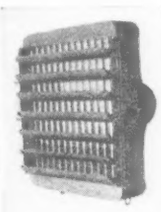


COMBINED HUMIDISTAT AND THERMOSTAT

"HYTHERSTAT" in case 4½ in. x 7 in. x 1¾ in., controls temperature and humidity with air-conditioning. "Comfortrol" is same except dials are intergeared to give control in terms of effective temperature. Bulletin C.—*Julien P. Friez & Sons, Inc., Baltimore St. and Central Ave., Baltimore, Md.*

HUMIDITY CONTROL

COMBINATION of Supreme solenoid water valve on Friez insertion humidistat. For installation in "cold-air returns" and cabinet-type conditioners. Electric valve especially designed for humidity work. Cast-iron case with terminal chamber for BX connections. Descriptive leaflet No. 3820.—*Supreme Electric Products Corp., Rochester, N. Y.*



UNIT HEATERS

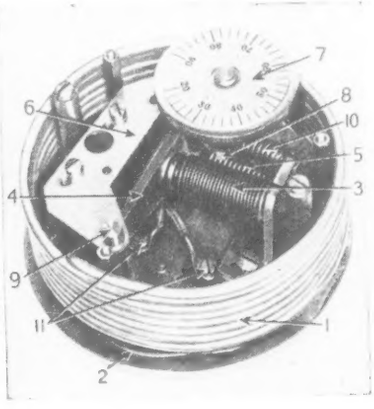
SPECIAL baked-crackle color finishes, including Spanish ivory, heather brown, silver, Pacific blue, etc.—*Ilg Electric Ventilating Co., 2850 North Crawford Ave., Chicago, Ill.*

TEMPERATURE CONTROL VALVE

THERMOTON valve, operated by liquid expansion, provides low-cost approximate temperature control by automatically varying flow of steam to heating coil or jacket. Actually is an orifice automatically varied in size by position of needle valve controlled by temperature of expansible member in turn proportional to volume of steam flowing. Will discharge condensate at any set temperature down to 90 deg. F.—*Sarco Co., Inc., 183 Madison Ave., New York, N. Y.*

ROOM THERMOSTAT

TYPE LSB connects to lighting circuit, and on a.c. can handle up to 1,000 watts without relay. Long bulb (1) connecting tube (2) and bellows (3) are filled with temperature-sensitive liquid. Temperature rise expands bellows, pushing lever (4) up, expanding loading spring (5). Lever contacts pin of microswitch (6) clicking it on or off. Adjustment made by turning dial (7). Dial shaft carries cam (8) which moves (4) closer to or farther away from (3) thus varying temperature at which contact occurs. Switch mechanism on pivot (9) held by spring (10). Lead wires carried through case at (11).—*Wilbin Instrument Corp., 40 East 34th St., N. Y. C.*



CLOSE-CONTROL HEATING SYSTEM

SAVINGS of 15% and more in use of steam after boiler room are claimed for new heating system with "Radiostat" control for low-pressure jobs for fairly large buildings. Also 42% average saving claimed in steam production costs through lower-priced coals, smokeless operation and increased efficiency, using automatic underfeed stokers. Unit governs firing through electronic tubes actuated by outside temperature. Folders 1517 and 1518.—*Link Belt Co., 2418 West 18th St., Chicago, Ill.*

DUCT INSULATION

DI corkboard for small commercial air-conditioning installations to prevent condensation rather than to conserve refrigeration. ½-in. thick, unaffected by moisture, with thin mastic coating on one side for strength, flexibility, seal against moisture, and finish. Erected readily in waterproof cement or asphalt. 12- or 36-in. sheets only.—*Armstrong Cork Products Co., Lancaster, Pa.*

AIR-CONDITIONING UNIT

INDUSTRIAL models FB-500, FB-800, FB-1400 and FB-2000 can be installed with or without distributing ducts. Automatic float control of refrigerant, ammonia, circulating brine or cold water. Unit inclosed in heavy steel casing with multi-blade, double-inlet fans, with V-belt drive. Automatic temperature control through thermostatic regulation, or by flow control.—*York Ice Machinery Corp., York, Pa.*

LARGER PORTABLE AIR-CONDITIONER

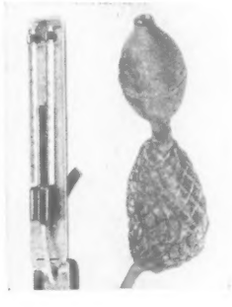
MODEL BA-100, companion to BA-75, is 45½ in. long, 17¼ in. deep, and from 36 in. to 45 in. high, depending on adjustment of telescopic intake duct adapter. New air-freshening device is hand-operated damper opened to pump out room. Electric panel permits operation on 110 or 220 volts, a.c.—*York Ice Machinery Corp., York, Pa.*

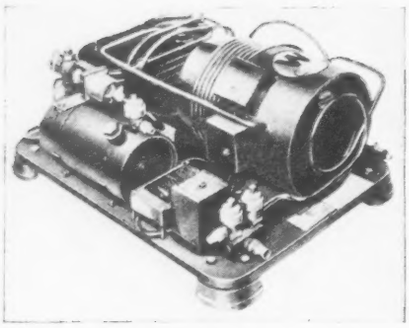
UNIT HEATER

"GRID" heater in four new sizes with all cast-aluminum heating sections bonded with steam chamber to prevent electrolysis. Capacities at 2-lb. steam pressure and 60-deg. temperature are: No. 515—56,750 B.t.u. with 1,290-c.f.m. air volume at fan; No. 520—97,500 B.t.u. with 2,500-c.f.m. air volume; No. 525—158,500 B.t.u. with 4,200-c.f.m., and No. 530—248,000 B.t.u. with 5,300-c.f.m. air volume at fan.—*Unit Heater & Cooler Co., Wausau, Wis.*

HAND-ASPIRATED PSYCHROMETER

WET- and dry-bulb thermometers similar to those in plain psychrometers, but arranged so aspiration over bulbs is induced by air from hand pump. Handle forms case, giving closed over-all length of 7½x1½x¾ in. Weight 12 oz.—*Julien P. Friez & Sons, Inc. Baltimore, Md.*





back is insulated. Standard model rated 500 watts. 110 volts a.c. or d.c. Special models for 220- and 440-volt a.c. or d.c. Over-all length 27⅝ in., width 5 in., depth 5¼ in. Thermostat adjustable to hold heat anywhere between 35 deg. and 60 deg. F.—*Rockwood Sprinkler Co., Worcester, Mass.*

CONDENSING UNIT

HERMETICALLY sealed condensing unit, Type WFB-33H, uses water as condensing medium and Freon as refrigerant. 24 in. long, 18½ in. wide, 11⅜ in. high, can be built into cabinet without louvres. 1/3-hp. capacitor type motor direct-connected to 2-cyl., 1 x ⅞-in. compressor.—*Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa.*

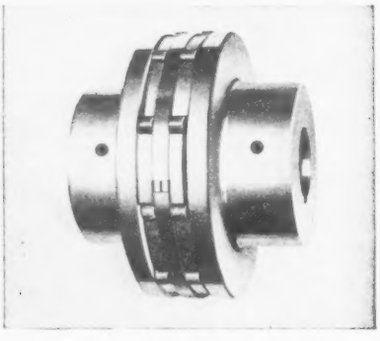
AUTOMATIC SPACE HEATER

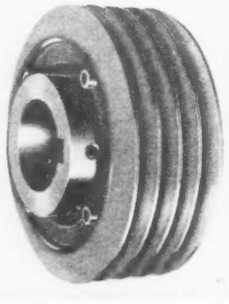
ELECTRIC heater consists of heating element, control thermostat, thermometer, pilot light, and 3-in. outlet box on pressed-metal frame. Metal guard protects heating element, and

JOINT COMPOUND

"COPALIT" packing and insulating compound in liquid and cake form is unaffected by benzine, benzol, mineral oil, dilute acids, high temperatures and pressures, and possesses high electric insulation properties. Satisfactory as sealing compound for machines using Freon, F-11, F-114, etc. Liquid for highly machined surfaces, paste for rough surfaces. "Rustnil" (diluted Copalit) for painting or spraying metal surfaces to prevent rust and resist corrosive liquids or gases. 1- and 5-gal. containers. No. 1 for brushing, No. 2 for spraying. Bulletin.—*National Boiler Improvement Co., 4100 Georgia Ave., Washington, D. C.*

MECHANICAL TRANSMISSIONS



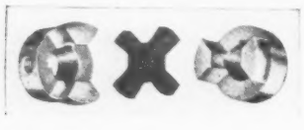


FLEXIBLE COUPLING

TYPE W non-lubricated, heavy-duty, coupling has individual load cushions free floating between metal jaws and secured by spiral steel spring. Cushioning materials brake-lining, leather or rubber-duck. Bores from 3 to 14 in. diam. for 18 to 2,000 hp. at 100 r.p.m.—*Lovejoy Tool Works, 5019 West Lake St., Chicago, Ill.*

FRACTIONAL-HORSEPOWER FLEXIBLE COUPLING

3-PART coupling has oil resistant rubber inserts to provide resilience and flexibility, quiet operation; shock and vibration absorption. No lubrication required. Three sizes, ½-, ¾- and 1-in. bore, transmitting 1/3, 1 and 5 hp., respectively, at 1,750 r.p.m.—*Certified Flexible Couplings, Inc., 122 East 42nd St., New York, N. Y.*

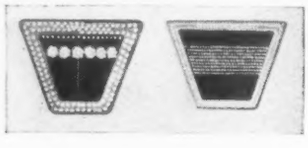


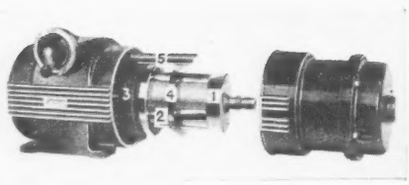
V-BELT SHEAVE

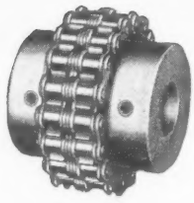
"DR" sheave consists of hub on which can be mounted rims of varying diameters and number of grooves. Rims can be mounted in four different positions so that hub can be about central or have required offset. Wide selection of diameters and number of grooves for "C" and "D" belts. Bulletin A-208.—*Dodge Mfg. Corp., Mishawaka, Ind.*

MULTI-V BELTS

Two styles of multi-V belts; one for small-pulley, short-center, high-speed drives is single-strand to withstand flexing and stretching. Other, for larger drives, has laminated construction with great number of cords and several layers of stiffening fabric.—*B. F. Goodrich Co., Akron, Ohio.*





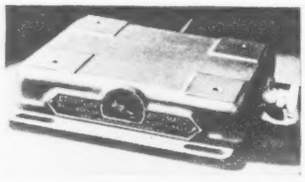


VARIABLE-SPEED TRANSMISSION

COMPACTLY housed transmission is about motor size and gives from ½ motor speed down to zero and reverse, with one turn of control wheel. Motor can be built in, connected to transmission by a flexible coupling, or unit may be driven from lineshaft or other power shafts. Geared head provides reduction up to 7 to 1 or step-up as high as 1 to 4. In latter case top speed can be as high as twice motor speed. With reduction gearing, full motor power can be developed at a top speed of 60 r.p.m. Can be controlled by remote or automatic unit by pressure or tension devices, cam, pilot motor, selsyn or other commonly used methods. Three standard sizes with range of capacity up to 7½ hp. and two speed ranges, normal and extreme.—*Graham Transmissions, Springfield, Vt.*

MOTOR BASE

"STRAITLINE" automatic base for operating with Vari-pitch Textrope sheave maintains uniform belt tension. Dial indicator shows tension. 4 ball-bearings support motor and upper half of base. Handwheel controls speed of sheave and moves motor to compensate for change in centers between shafts.—*Allis-Chalmers Mfg. Co., Milwaukee, Wis.*



ROUND LEATHER BELTING

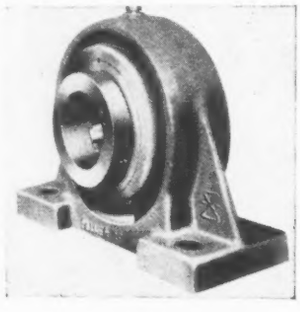
BELT hook buried in groove and hook ends clinched into opposite groove below surface, thus leaving smooth even, strong joint in this "Hook Groove" belting.—*Victor R. Clark Belting Co., 605 W. Washington Blvd., Chicago, Ill.*

SMALL-PULLEY BELT

"PLYTEX" for high-speed transmission over small pulleys has lightweight silver duck fabric. 4, 5, 6, and 7 plies from 1 to 8 in.—*Thermoid Rubber Co., Trenton, N. J.*

SELF-ALIGNING PILLOW BLOCK

CAST-STEEL housing with ball-and-socket bearing that permits free oscillation of about 3 deg.—*Palmer-Bee Co., Detroit, Mich.*

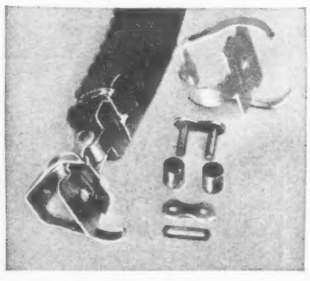


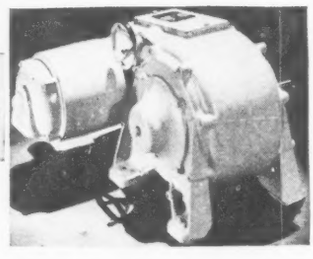
FLEXIBLE COUPLING

IMPROVEMENTS consist of two sprockets encircled by links of double-strand roller chain. Clearance between sprocket teeth and chain side to permit misalignment of connected shafts. Double-strand chain gives coupling of a given size more horsepower capacity, and permits use of larger shafts for given outside diameter.—*Diamond Chain & Mfg. Co., Indianapolis, Ind.*

V-BELT COUPLER

"GRIP-FLEX" roller-bearing coupling in all standard sizes from A to E in a variety of types to suit belt, strength and size. Other sizes to order. Anchor plate surrounds belt ends. Side plates and replaceable roller bearings. Friction pin is self lubricating raw-hide type. Permits belt to be cut to size from roll stock. Bulletin 36.—*Shippert Mfg. Co., Dept. P, 414 South Galean Ave., Dixon, Ill.*





POWER UNIT

"SPEED-TROL," inclosed, infinitely variable-speed transmission and motor for ¼ to 15 hp. has medium-width V-belt running in alloy-iron pulleys on parallel shafts. Handwheel changes diameter of both pulleys through chains and sprockets. Single or multiple reduction. All types of motors and remote and automatic controls.—*Sterling Electric Motors, Inc., Telegraph Rd. at Atlantic Blvd., Los Angeles, Calif.*

LIGHT-DUTY BELT

BELTPACO JR. may also be used as shaping or forming belts for light conveyors. Extra plies for "body", yet flexibility allows belt to hug pulleys.—*New York Belting & Packing Co., 1 Market St., Passaic, N. J.*

LOCK BEARING

"GRIP-LOCK," self-aligning, extended inner race bearing has spring-steel locking shoe in eccentric groove machined in bore of inner race.—*SKF Industries, Inc., Front St. & Erie Ave., Philadelphia, Pa.*

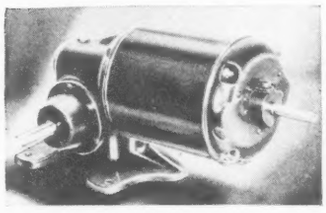
COMPOSITION BELT

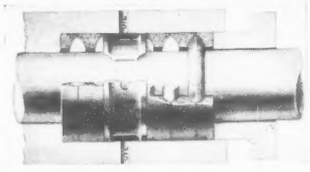
STYLE "F" has red friction pulley surface for use where slight starting

slip is desired. Style "B" has bare-back untreated duck pulley surface where greater slip is required or where slip is essential, as in winder drives.—*Manhattan Rubber Mfg. Division of Raybestos-Manhattan, Inc., Passaic, N. J.*

FRACTIONAL-HP. GEARMOTORS

AVAILABLE in single- and double-reduction with right-angle-shaft drive, and single-, double- and triple-reduction for parallel-shaft drive. Speeds as low as 6 r.p.m. Illustration shows single-reduction right-angle drive with out-speed of 30 r.p.m., driven by 1/6-hp., 110/220-volt, 60-cycle, 1,725-r.p.m. motor. Ball-bearing, single-phase, repulsion-start-induction motor with high-speed shaft extension. —*Wagner Electric Co., 6400 Plymouth Ave., St. Louis, Mo.*





PACKING FOR HIGH-SPEED SHAFT

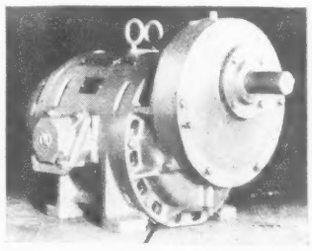
"LOCKRING" seal for Freon, ammonia, oil or water. Every ring self-adjusting. Rings of soft metal cushioned with asbestos laminated and molded and vulcanized at high temperatures. Asbestos rings are resilient. Slight pressure on gland expands them to stuffing box wall, and compresses all metallic rings evenly to shaft.—*Williams Gauge Co., 1620 Pennsylvania Ave., N. S., Pittsburgh, Pa.*

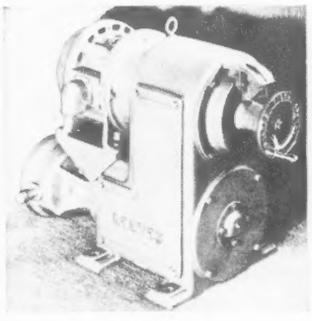
BRAKE LINING

STYLE No. 900 woven and compressed brake lining for heavy industrial equipment, incorporates solid woven lining with wearing qualities of compressed styles. Flexible; readily formed; adaptable to various speed requirements; mechanically strong; will withstand severe shock-loading.—*Johns-Manville, 22 East 40th St., New York, N. Y.*

GEARMOTORS

EXPLOSION-PROOF units from 1½ to 75 hp. For Class 1, Group D, hazardous locations. Single helical gears, heat-treated. Approved for inflammable vapors.—*Westinghouse Elec. & Mfg. Co., East Pittsburgh, Pa.*





VARIABLE-SPEED MOTOR DRIVE

COMBINES in one inclosure any standard constant-speed motor, control mechanism, and (where required) speed-reduction gears. Dial indicator registers speeds on scale calibrated from 1 to 6, as handwheel is turned. V-belt runs between two sets of cone-faced disks adjustable in diameter and mounted on parallel shafts. Variable-speed shaft may extend on either side. Horizontal vertical drives in four sizes from ¼ to 7½ hp. for ratios from 2 to 1 through 6 to 1. With helical gear units ratios up to 189 to 1. Output speeds from 1.35 to 3,480 r.p.m.—*Reeves Pulley Co., Columbus, Ind.*

BELT PULLEY BANDAGES

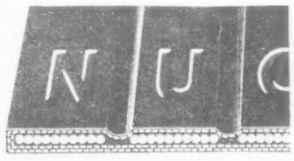
"CONTRASIT" permits operation with slack belts, eliminates resin and insures even pull. For wood, iron, steel and leather, stepped-cone and common pulleys. Agents: *Scann-American Sales Service, 200 Broadway, New York, N. Y.*

VULCANIZER

ALUMINUM lowers cost of vulcanizer for belting up to 28-in. and reduces weight to 300 lb. 100 and/or 220 volts a.c. and d.c.—*Mechanical Rubber Goods Div., B. F. Goodrich Co., Akron.*

MULTIPLE FLAT-BELT DRIVE

"NUCORD" belts, grooved for pliability, said to be equivalent to medium double-thickness leather belts or 5-ply rubber belts. Cords gum dipped, then coated with special compound. Ten cords per inch of belt width. Endless belts up to 300 ft.; rolled belts up to 500 ft., and flat belts from ¾ in. to 12 in. wide.—*Nucord Co., 605 West Washington Blvd., Chicago, Ill.*



VIBRATION-DAMPING INSULATORS

"VIBRO-INSULATORS" are age-resisting rubber attached to metal plates with brass-plating type of bond, which gives adhesion of 200 lb. per sq. in. Three types: No. 1 with maximum load capacity of 800 lb., and minimum frequency of 800 vibrations per minute. Type No. 2 with maximum load of 200 lb. and minimum frequency of 1,200. Type No. 10 double-shear type with minimum frequency of 1,000 vibrations, and in a range of sizes for loads of 50 to 3,000 lb.—*B. F. Goodrich Co, Akron, Ohio*

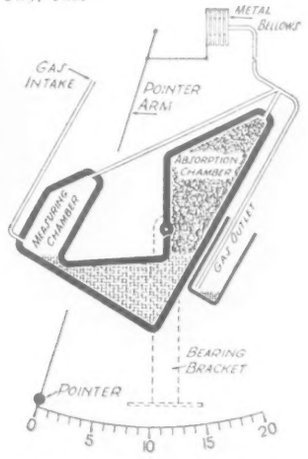
BELT LACING

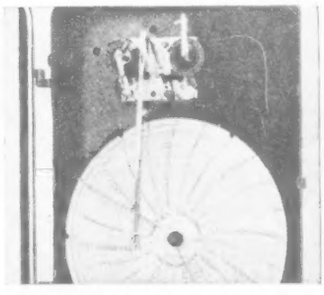
"TEK-LACE" non-metallic, for flat belts or V-belts, 0.055 in. in diameter, has tensile strength of 100 lb. A 3-in. belt fastened with this lace has a tensile strength of 2,000 lb. at the joint. Holes for it are pierced. —*Sudbury Lab., P. O. Box 940, South Sudbury, Mass.*

mounting. Meter bodies for from 1 to 200 in. of water.—*Cochrane Corp., 17th St. and Allegheny Ave., Philadelphia, Pa.*

AUTOMATIC ORSAT

"ORSATOMAT" analyzes flue-gas sample in 20 sec. by simply operating a lever. No valves and no manual leveling or measuring. Results indicated by pointer movement on large scale. Rotatable analyzing body contains measuring and absorption chambers and charged with mercury and absorbing chemical, metallic bellows and linkage for moving pointer, aspirator bulb and necessary rubber tubing, all in pressed-steel case of non-tipping design with carrying handle. Sample is taken in while instrument is in position illustrated. Absorbing chemical retains strength for long period.—*Hays Corp., Michigan City, Ind.*





RECORDING THERMOMETER

SMALL-BULB, gas-filled, for —60 to 1,000 deg. F., where tubing 100 ft. long or more is required. Rectangular case, one or two pens with 12-in. chart, one with 8-in. size. Catalog 1250.—*Bristol Co., Waterbury, Conn.*

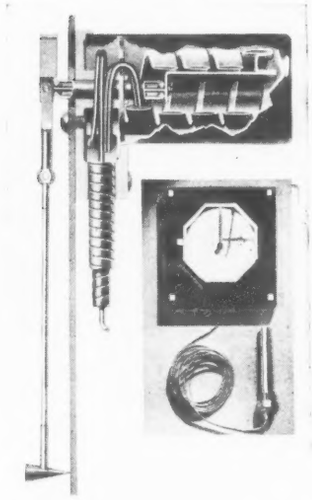
STROBOSCOPE

PORTABLE Stroboglow producing momentary 300,000 c.p. with flash duration of about 10 microseconds. Inbuilt electronic timer. Mechanical contactor or high voltage used to trip lamp in Type PSE-2. 100 to 30,000 cycles per min.—*Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa.*

ILLUMINATION METER

VEST-POCKET photo-electric meter reads up to 250 foot-candles. Scale divided in five "seeing task" zones set off by colored divisions. 2⅜x2¾ in.—*Weston Electrical Instrument Corp., Newark, N. J.*

METERS, RECORDERS AND TESTING INSTRUMENTS

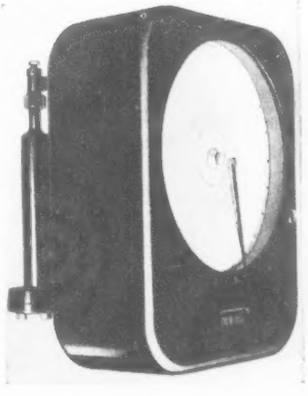


RECORDING THERMOMETER

GAS-FILLED unit with helical-coil cartridge-sealed as a protection against dirt, moisture and handling. Helix, capillary tubing and sensitive bulbs welded together, filled with nitrogen, calibrated and sealed in laboratory. Unit can be readily removed from reading instrument for recalibration, repair or change of range without disturbing or exposing any mechanism. Highly sensitive, accurate and trouble-free. Standard bulbs for measuring flue-gas temperature, average temperatures of large areas, temperatures in open vats or tanks, closed tanks under pressure or vacuum pipe lines, refrigeration systems, etc. Operating ranges —20 to +1,000 deg. F. One, two or three records. Data Book No. 210.—*Republic Flow Meters Co., 2240 Diversey Parkway, Chicago, Ill.*

PRESSURE EQUALIZER

FOR instruments subject to shock, pulsation or chatter from changes of pressure. Brass or Bronze. *National Boiler Improvement Co., Inc., 4100 Georgia Ave., Washington, D. C.*

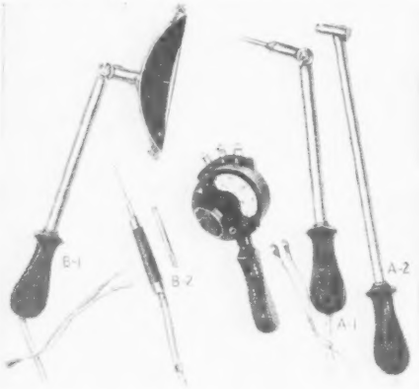


ORIFICE METER

DIRECT-READING integrator, 12-in. chart, spring or electric clock drive, interchangeable manometer tubes, removable cover plates and forged-steel float chamber. Flush panel or rear

PYROMETERS

FOUR types of surface and needle elements for use with one indicator. Type A-2 where small thermocouple contact (about ¼ in. diam.) is required, has universal joint. A-2 offset handle type for flat surfaces. B-1 for determining surface temperatures of stationary or moving rolls also has universal joint. B-2 has thermocouple in hollow needle. Bulletin No. 60-A. —*Pyrometer Instrument Co., 103-5 Lafayette St., New York, N. Y.*

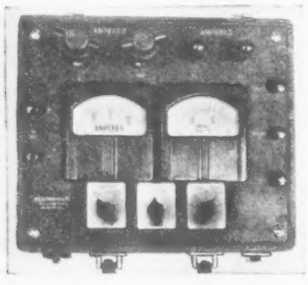


SPEED RECORDERS

FOR continuously indicating and recording speed at any desired location, "Micromax" speed recorder has heavy-duty tachometer magneto attached to rotating shaft, which generates electromotive force proportional to speed. Lead wires connected to Micromax recorder of type preferred. Recorder records on moving chart or actuates signals.—*Leeds & Northrup Co., Philadelphia, Pa.*

D. C. ANALYZER

8x11x13 in., has ammeter with self-contained shunts for 7½, 75, 750 amp., which can be changed to 50-millivolt instrument by switch. Second instrument reads volts and ohms, has switch for changing ranges. Voltage ranges 150, 300, and 750 volts. Ohm ranges are 5 and 500 at center of scale, can be read from 0.1 ohm to 20,000 ohms.—*Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa.*

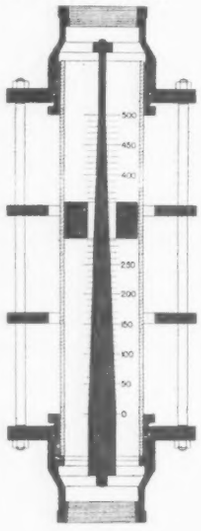


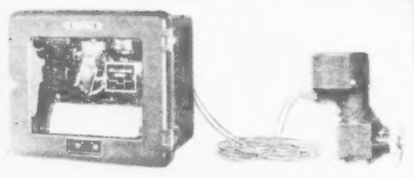
BAROGRAPH

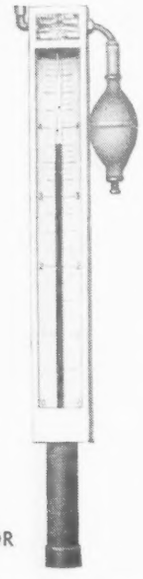
MICROBAROGRAPHS show minute fluctuations of barometer as continuous inked record. Recording scale expanded in ratio of 2½ to 1. Jeweled clock movement.—*Julien P. Friez & Sons, Inc., Baltimore St. & Central Ave., Baltimore, Md.*

FLOWMETERS

THIS taper-pole Rotameter uses a straight tube with a tapered pole or metering pin, larger at bottom, in its center. On this pole, a ring-shaped indicating element called a "rotor" rises with increasing flow to increase orifice area. Rotor in close proximity to tube, so can be seen readily even in dark liquids. A variation for measuring flow of liquids which become very viscous near room temperatures uses a hollow metering tube through which steam or hot water flows. Protecting case can be placed around meter to prevent heat loss.—*Schutte & Koerting Co., 12th & Thompson Sts., Philadelphia, Pa.*







MERCURY-VAPOR DETECTOR

DETECTED by selenium-sulphide paper strips which turn brown when exposed. Knowing how long selenium-treated paper has been exposed and determining intensity of brown by comparison with chart, concentration of vapor can be determined. Heat from lamp causes fairly constant flow of warm air up through cone so that apparatus may be calibrated. Color scale has six colors uniformly graduated. —*General Electric Co., Schenectady, N. Y.*

PORTABLE TESTING BOX FOR RELAYS

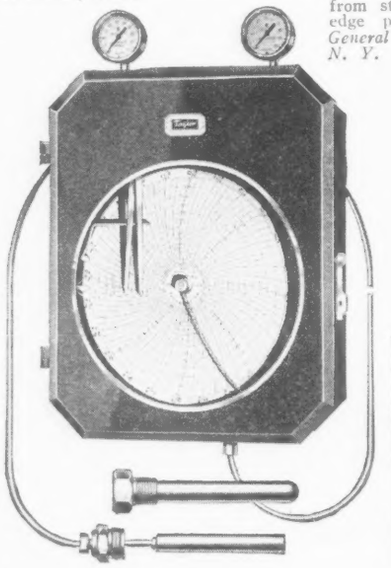
15-LB., 9x10x7½-in. For distance, reactance or impedance relays, operable by one man in field. Requires external resistors and reactors (portable). No phase-angle meter necessary.—*General Electric Co., Schenectady, N. Y.*

PORTABLE VOLT-WATTMETER

COMBINATION volt-wattmeter to suit Type AP-9 series. Over-all accuracy ¾% of full-scale value.—*General Electric Co., Schenectady, N. Y.*

SEPARABLE THERMOCOUPLE WELL-TUBE SYSTEM

TO OVERCOME time lag caused by extra thickness of metal and dead air space between well and bulb, "Thermospeed" is claimed to have a speed closely approaching bare-bulb thermocouples.—*Taylor Instrument Cos., Rochester, N. Y.*



PORTABLE THERMOMETER

SENSITIVE element (bulb), mercury-filled, outside cases for quicker response. Black-enameled, die-cast aluminum case. Gasketed, moisture-proof door with tamper-proof lock. Records on 8-in., 24-hr. chart.—*Brown Instrument Co., Wayne Junction, Philadelphia, Pa.*

ATMOSPHERIC PRESSURE-TANK GAGE *(Left)*

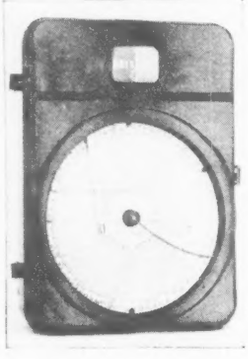
AIR-ACTUATED unit using mercury as measuring medium and non-evaporating red oil in a glass tube to indicate. Mercury chamber at bottom is concentric U-tube. Bulb at top right-hand side serves as air pump which connects with small tube that passes down behind indicating dial to bottom of outer chamber of U-tube. Air pumped in, bubbles through mercury of this chamber and out through connection at top left-hand side of gage in tank. Air thus trapped by mercury can escape only through opening of copper tubing at bottom of tank being measured. Air pressure cannot be increased by continuous pumping. When liquid measured is above required position of indicator, pumping air is not necessary as liquid may be piped directly to instrument.—*T. W. McNeil Engrg. Equipt. Co., 4057 Van Buren St., Chicago, Ill.*

BOILER-WATER DENSITY METER

"DENSIMETER," small floating glass bulb, sinks when placed in warm boiler water. Water is stirred with thermometer graduated in grains per gallon (from 25 to 500) until water cools to point where bulb floats. Bulb is in metal carrying-case and thermometer has pocket clip.—*National Aluminate Corp., 6216 West 66th Place, Chicago, Ill.*

POCKET-SIZE INSTRUMENTS

TYPE AS-5 pocket-size voltmeters, ammeters and milliammeters incorporate element with higher torque and improved characteristics. Over-all dimensions 5½ x 3½ x 2 in., and weight 12 oz. Accuracy 1% of full-scale value. Magnetic damping, Permaloy moving vane, shielding from stray magnetic fields. Knife-edge pointer and mirror scale.—*General Electric Co., Schenectady, N. Y.*

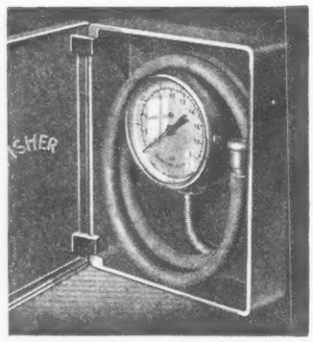


ROUND-CHART METERS

RECORDING voltmeters and ammeters in wall, switchboard, flush-panel, pole, and portable models. All have moisture, fume and dustproof case. Measuring element can be replaced easily by removing three screws from mounting. Micrometer zero adjustment and replaceable chromium-plated tip on pen arm. 2-drop, fine-bore platinum-point fountain pen. Bulletin No. 436.—*Bristol Co., Waterbury, Conn.*

LOW-PRESSURE TEST GAGE

DIAL calibrated from 0 to 35 in. of water and from 0 to 20 oz. in this "Figure 50" test gage. Bronze diaphragm, 2½-in. diam. black steel case, nickel ring and 1/4-in. pipe-thread bottom connection or in cast-alluminum case 2¼x5x6 in. with 3 ft. of flexible hose.—*Fisher Governor Co., Marshalltown, Iowa.*



INSTRUMENT TRANSFORMERS

SEVERAL current and potential instrument transformers in ratings of 23 to 161 kv. Oil or pyranol filling. Primaries wound on porcelain spools which serve as main part of insulation between primary and secondary. Current transformer mounted in shallow base and extends up into

porcelain shell, used as high-voltage bushing. Potential transformers for use only on 3-phase, 4-wire grounded systems, and replace single-bushing convential type. In voltage classes below 69 kv., units are single core-and-coil assembly in a shallow tank and extending up into a porcelain shell which serves as high-voltage bushing. Above 69 kv., transformer consists of two or more core-and-coil units mounted vertically and connected in cascade.—*General Electric Co., Schenectady, N. Y.*

DIAL THERMOMETERS

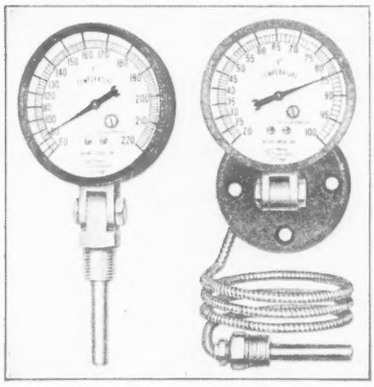
TYPE 61 self-contained universal-socket thermometer eliminates specific stem for each application. Type 62 distant-reading thermometer with 6 ft. of connecting tubing and union or flexible bulb. Mounting flange with universal-socket. Ranges from 20-deg. below to 800-deg. above zero. 3½-in. dial.—*Jas. P. Marsh Corp., 2073 Southport Ave., Chicago, Ill.*

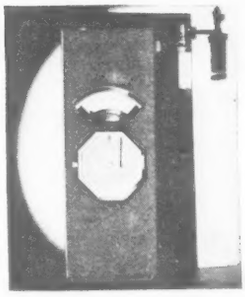
ROTARY DISPLACEMENT METERS

2½ x 7-in meters for line pressures up to 25 lb. per sq. in., have normal capacity of 5,000 cu. ft. per hour at 1-in. w.g. differential, but maintain commercial accuracy on loads from 10 to 150% of normal rating. Base for foundation mounting, or special bottom pipe plate for direct mounting in vertical gas line.—*Roots-Connersville Blower Corp., Connersville, Ind.*

THERMOMETER TUBING

"BINOC" tubing has more than twice normal angle of vision with high magnification of mercury column. Thermometer itself has large black numerals on cream-colored background. All straight, angle, and handled forms. Bulletin 99023—*Taylor Instrument Cos., Rochester, N. Y.*





CO_2 METER

PERCENT CO_2 measured by Orsat. Meter built to duplicate, mechanically, this chemical analysis. Driven by fractional-horsepower motor and requires no water. 14-in. Hg. mercury suction to avoid stoppage in gas line. Large caustic tank holds enough potash to last 4–6 mo. Temperature variations do not affect meter readings. Permanent continuous pen-line record. Arrangements of indicators and recorders to fit any requirement. Related factors, such as steam flow, temperature, draft, pressure, etc., may be combined on one circular chart. Data Book 403.—*Republic Flow Meters Co., 2240 Diversey Parkway, Chicago, Ill.*

REMOTE-READING GAGE

"EYE-HYE" shows precise level of boiler water as bright green liquid, sharply illuminated. Brings reading down around corners, girders, piping, etc.—*Reliance Gauge Column Co., Cleveland, Ohio.*

slotted and has adjusting screws for belt adjustment. Fits NEMA standardized dimensions, also has universal bases for fractional-hp. motors.—*W. D. Fabling Co., 2043 Sacramento St., Los Angeles, Calif.*

AUTOMATIC ALTERNATOR VOLTAGE REGULATOR

TYPE EF is a quick-acting, simple and accurate a.c. voltage-generator regulator operator in exciter shunt field. Is an electronic-controlled rectifier, deriving power from a.c. generator and delivering rectified d.c. to exciter shunt field. High speed of response, because exciter shunt-field voltage is independent of exciter armature voltage. Automatic protection for field winding as field current is rapidly reduced, thus no field-discharge resistor is required across exciter shunt field while regulator is in operation. Bulletin 5601-A.—*Ward Leonard Electric Co., Mount Vernon, N. Y.*

FISH-TAPE REEL

"IDEAL" reel keeps tape coiled and protected and serves as handle for sure grip. Standard reels 100 ft., but will hold as much as 250. Two sizes, ⅛x0.060 fish tape, and 3/16 by 0.060 fish tape. End automatically locked within reel.—*Ideal Commutator Dresser Co., 1025 Park Ave., Sycamore, Ill.*

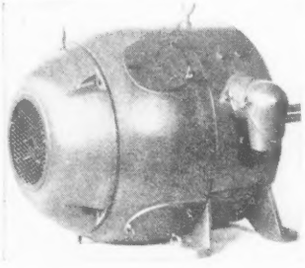
VOLTAGE REGULATORS

Two lower ratings for a.c. machines up to 375 kva. at 3,600 r.p.m. and smaller ratings at correspondingly lower speeds. Types GDA-1M, and GDA-1.—*General Electric Co., Schenectady, N. Y.*

7500-VOLT, 500-AMP. CABLE TERMINATOR

CAP nut and cover gaskets in a recess. Cap nut compresses gasket, then makes direct electrical contact with bronze cap cemented to porcelain. Constant pressure on gasket and stud threads assured by laminated spring washer integral with stud. Vertical soldering holes in stud connector.—*Delta-Star Electric Co., Chicago, Ill.*

MOTORS, ELECTRICAL AND ELEVATOR EQUIPMENT



FAN-COOLED, INCLOSED D.C. MOTOR

TYPE SK 5- to 75-hp. motor for 115, 230 and 550 volts d.c. Pulley may be mounted close to bearing and motor may be close to wall without interfering with ventilating.—*Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa.*

RIVETED-FRAME MOTORS

SQUIRREL-CAGE polyphase induction motors in riveted-frame sizes of 1 to 15 hp. at 1,800 r.p.m. Improvements in stator-coil insulation, frame construction and other elements. Units can be used interchangeably, since types include open, sleeve- or ball-bearing, inclosed, inclosed fan-cooled, splash-proof, vertical, etc. Illustrated cut-away view of open sleeve-bearing type. Malleable-iron end frames; cast-iron end shields. 2-part conduit boxes. Ball bearings provided with pressure grease fitting and relief plug; sleeve bearings equipped with oil-filler gage on either side of housing. Bulletins GEA-2345, GEA-1326C, GEA-1341C, GEA-1538A, and GEA-1619B.—*General Electric Co., Schenectady, N. Y.*

INCLOSED FAN-COOLED D.C. MOTOR

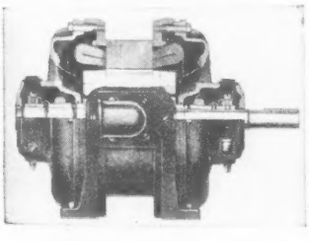
HAS external fan and shroud on commutator end. Remove one cover from bracket opening to reach brushes. Inner supporting bearing bracket cast integral with outer air shroud.—*Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa.*

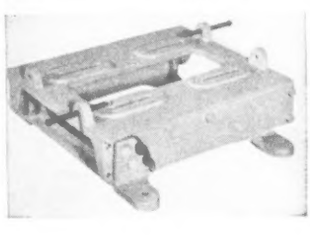
SQUIRREL-CAGE MOTORS

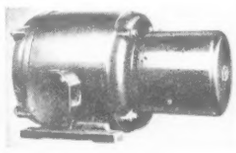
SPLASH-PROOF, all ratings from ½ to 200 hp. for constant-speed and multispeed continuous or intermittent duty in all voltages and cycles for any torque and starting current. Protection for inner parts from splash or spray, yet proper ventilation by small openings in bottom of end brackets for air intake and in frame cover under motor for exit.—*Imperial Electric Co., Akron, Ohio.*

SINGLE-PHASE INDUCTION MOTOR

TYPE CR, single-phase, repulsion-start motor has high starting and pull-in torques. ¾- to 3-hp. sizes for 110/220 volts on all commercial frequencies. At about 60% of synchronous speed, centrifugal device short-circuits armature and motor acts as squirrel-cage induction.—*Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa.*







FAN-COOLED MOTORS

TYPE SK, explosion-tested, fan-cooled, totally enclosed, d.c. motors in sizes from 5 to 75 hp. and 115, 230 and 550 volts. Brushes and commutator accessible. Fan on commutator. Special double-walled front bracket with four screw-type handle covers removable for adjustment of brushes and commutator.—*Westinghouse Electric & Mfg. Co., East Pitsburgh, Pa.*

SOUND-ISOLATING MOTOR BASE

"SOUND-PRUF" base is a floating platform supported by resilient rubber balls set in recesses between parallel flanges. Number of balls can be adjusted to suit weight and operating conditions. Motor-support platform

MOTOR-MOUNTED BRAKE

TOTALLY enclosed, automatic solenoid brake integral with motor from fractional to 10 hp. (at 3,600 r.p.m.) supplies already mounted, on any motor, from the motor manufacturer. Rotating member is a single, heavy, molded disk. Enclosing case. A.c. or d.c., with dust tight, weather-proof and watertight enclosures.—*Cutler-Hammer, Inc., 294 N. Twelfth St., Milwaukee, Wis.*

A. C. VOLTAGE REGULATOR

FOR small a.c. generators. No moving parts. Current, proportional to load, compounds exciter field, varying with generator voltage. Energy obtained from generator potential through combination of reactor, resistor and dry-type rectifier circuits. For units where exciter field current is 1 amp. or less.—*Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa.*

SELF-REGULATING BATTERY CHARGER

RECTOX, with no moving parts, maintains battery voltage at required value within plus or minus 1.75% for load variations down to 10% full-load rating, and variations in line voltage of plus or minus 10%.—*Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa.*

METAL-CLAD SWITCHGEAR FOR LIGHT DUTY

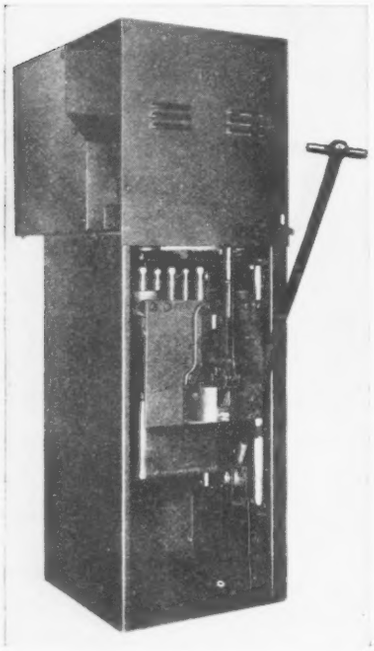
TYPE MI-9 uses Type FK-42 removable oil circuit breaker in either of two ratings—600 amp. and 5,000 volts, or 800 amp. and 2,500 volts, both with an interrupting rating of 25,000 kva. Manually or electrically operated. Self-contained elevating mechanism with removable lever, bus, and interconnections.—*General Electric Co., Schenectady, N. Y.*

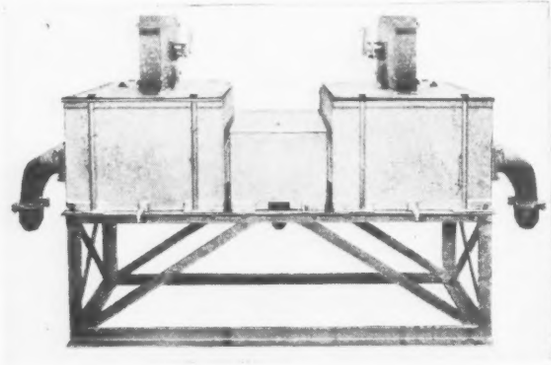
DISCONNECT SWITCH

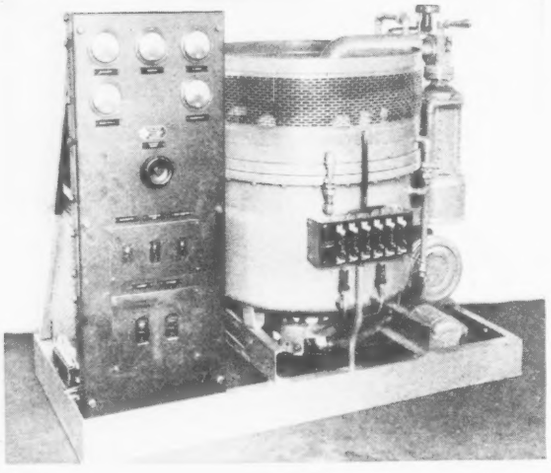
OIL-IMMERSED 15-kv. disconnect switch to handle additional feed sources at reasonable cost. Watertight. Suitable in dirt, dust and explosive hazards.—*Delta-Star Electric Co., Chicago, Ill.*

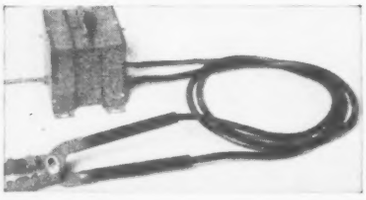
SURGE PROTECTORS AND ARC SUPPRESSORS

NO CURRENT flows in gaseous-discharge tubes until voltage is sufficient to ionize gas. For surge protection, tube rated at 125, 250 or 500 volts d.c. is shunted across coil or magnet between switch and coil and reduces potential to nominal in 0.010 to 0.1125 sec. after opening circuit. Junior line has 10-amp. current-carrying capacity, heavy-duty line 100 amp. Arc suppressor reduces voltage rating of condenser needed across switch points. Bulletin.—*Sundt Engrg. Co., 4238 Lincoln Ave., Chicago, Ill.*









ELECTRIC PLIERS

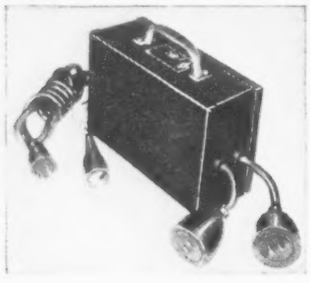
INTERCHANGEABLE switchgear for incarbon blocks in ends of jaws which carry large currents at low voltage from transformer to sides of fitting to be heated. Used include soldering, sweating joints, etc. 110 volts, 25, 50-60 cycles and 220 volts 50-60 cycles.—*Ideal Commutator Dresser Co., 1025 Park Ave., Sycamore, Ill.*

OIL CIRCUIT BREAKER

INDOOR, FZ-220, station-type breaker from 500,000 to 2,500,000 kva., and 15 kv. to 34.5 kv.—*Condit Electrical Mfg. Co., Hyde Park Station, Boston, Mass.*

TRANSFORMER FOR INSPECTION AND MAINTENANCE

PORTABLE transformer has primary cord, rubber-covered, which may be plugged into any 110-volt, 60-cycle circuit. Two secondaries to which extension cables are attached consist of vulcanized approved cable with special non-pullout plugs. Secondary current rated at 32 volts.—*Acme Electric & Mfg. Co., Cleveland, Ohio.*

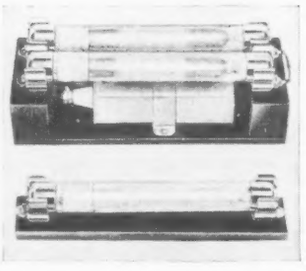


LOW-CAPACITY RECTIFIERS

SIMPLIFIED, assembled, grid-controlled mercury-arc rectifier with rating of 150 kw. at 250 volts and 300 kw. at 550 volts, d.c. Rectifier tank, auxiliaries and control panel assembled and wired on common frame. 3½x6 by 5 ft. high.—*Allis-Chalmers Mfg. Co., Milwaukee, Wis.*

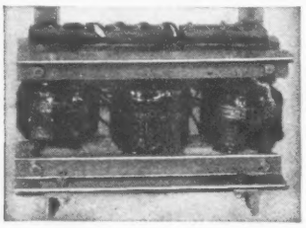
600-VOLT, 100-AMP. PLUGS AND RECEPTACLES

FOR extra-heavy duty. "Jumbo-Type" has elements held in position by screwing together heavy metal outer sections. Receptacles are tapped for 2-in. conduit and for smaller sizes; reducing bushing is used. 2-, 3-, and 4-pole combinations. — *Delta Star Electric Co., Chicago, Ill.*



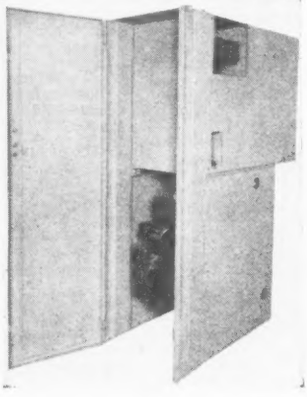
PHASE TRANSFORMER

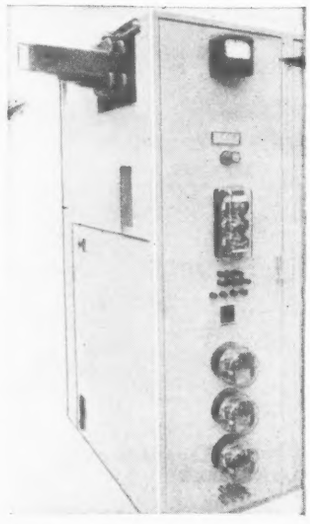
SEMI-PORTABLE, air-cooled, transformer features ease of handling and installation. Active parts attached to steel angles, inclosed in steel case. Terminals for 220, 440 and 550 volts, 3-phase, 60 cycles. Special transformers for 2-phase or other voltages. Changes 220 to 440 and 550 volts, 440 to 220 and 550 volts, 550 to 220 and 440 volts. 1 to 50 kva.—*Forbes & Myers, 172 Union St., Worcester, Mass.*



METAL-CLAD SWITCHGEAR

TYPE RA 3-phase unit, 20x40x62 to 70 in., can be mounted in banks of two or more. All live parts steel enclosed, and elements in separate compartments with steel barriers between. 5-kv., 600-amp., 25,000- and 50,000-kva. oil-blast circuit breakers are interchangeable with other units of same rating. Positive interlock.—*Delta-Star Electric Co., Chicago, Ill.*



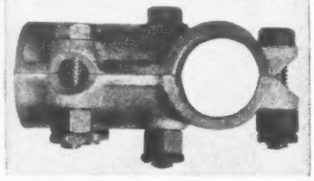


METAL-CLAD SWITCHGEAR

INTERCHANGEABLE switchgear for installation in as many sections as desired has steel-inclosed sections side by side. Each section has manually operated oil circuit breaker, ammeter, watthour meter and overload relays. 7-ft. high by 5 ft. deep by 2 ft. 2 in. wide.—*Delta-Star Electric Co., Chicago, Ill.*

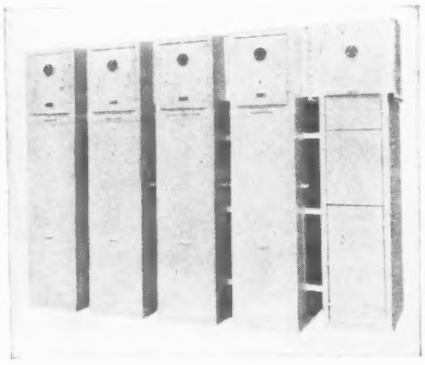
SOLDERLESS CONNECTORS

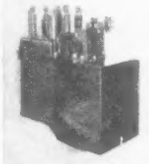
CLAMP-type, in equal halves cast to size. Sharp, minute projections dig into copper-tube conductor for permanent contact. Non-ferrous bolts, nuts and lockwashers.—*Delta Star Electric Co., 2400 Block Fulton St., Chicago, Ill.*



METAL-CLAD SWITCHGEAR

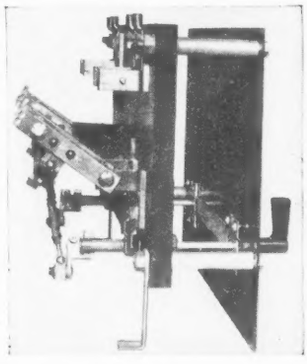
ILLUSTRATED is a 4-unit, 3-pole, 800 amp., solenoid-operated oil circuit breaker with current transformers, relays and plus disconnectors with interlocks. Main bus in top compartment. Right-hand or fifth unit houses three potential transformers and 3-pole group-operated disconnecting switch interlocked with door. 7.5-kv. unit.—*Delta-Star Electric Co., Chicago, Ill.*





FUSE CLIP CLAMP

STEEL clamping ring is forced over outside of jaws, exerting high pressure against fuse or switch clips, accomplished simply by turning knob. Grips all clipped equally irrespective of width. Cuts down resistance, prevents burning and pitting.—*Ideal Commutator Dresser Co., 1025 Park Ave., Sycamore, Ill.*



MANUAL FIELD-DISCHARGE SWITCH

TYPE LF-23 switch is deadfront, mounted in back of board, and rated at 250 volts d.c., 100 and 200 amp. only. Double-throw switches are two single-throw switches with mechanical interlock to prevent closing both throws at once. Operating handle and escutcheon like those of Type SB-1 control switch.—*General Electric Co., Schenectady, N. Y.*

DIRECTIONAL DISTANCE RELAY

TYPE GCX12A high-speed, 3-phase unit consists of three starting elements, three resistance units, and a timing unit, also two instantaneous over-current units, one for each of two phases, to prevent tripping on fault currents less than their setting. Units connected with coils in series, with current windings of starting units and their contacts in series with main tripping contacts. Each overcurrent unit has calibrated settings of 4, 7 and 10 amp. Operating time on phase-to-phase faults in proximity to the relay will range from 1 to 1½ cycles, with corresponding currents of 20 to 10 amp. Remote faults increase time.—*General Electric Co., Schenectady, N. Y.*

TRANSITE CONDUIT

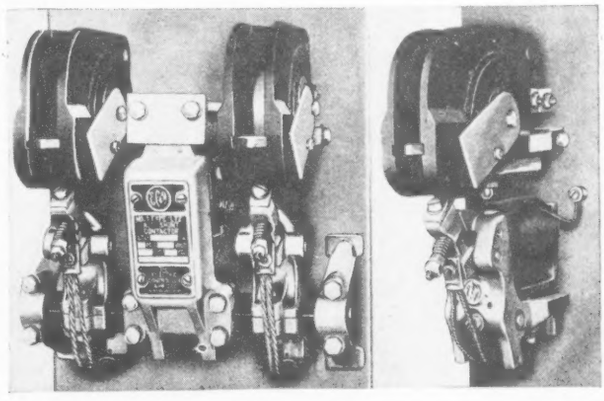
"TRANSITE-KORDUCT" asbestos-cement product has smooth interior. Thin-walled for duct inclosed in concrete. Rot-proof, incombustible, immune to electrolysis and corrosion, high heat-dissipation rate. — *Johns-Manville Corp., 22 East 40th St., New York, N. Y.*

INDOOR BREAKERS

TYPE F-122 solenoid-operated oil circuit breakers rated at 25,000 kva. manually and electrically operated up to 600 amp., 7,500 volts, and 800 amp. 2,500 volts, 2- and 3-pole, single-throw. Operating levers inside breaker chamber away from live contact terminals. Panel or panel frame mounting direct control; wall, pipe, or structural-steel frame mounting remote control. Electrically operated breakers may be arranged for wall, pipe or structural-steel frame mounting, remote control. Type SAF-2 solenoid-operated mechanism is separate but mounted directly on breaker. —*Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa.*

MAGNETIC CONTACTOR

TYPE LT for d.c. and LTZ for a.c. "Line-Arc" contactors, of aluminum alloy for quick motion. No. 1-Type LTZ, 3-pole contactor, said to be able to make 650 operations per min. Cold-formed copper contacts. Arms assembled on and insulated from square steel shafts on "Oilite" self-aligning, self-lubricating bearings.—*Electric Controller & Mfg. Co., 2700 East 79th St., Cleveland, Ohio.*

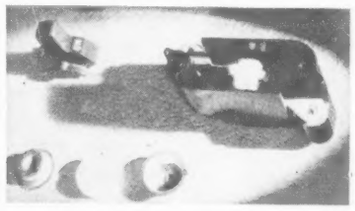


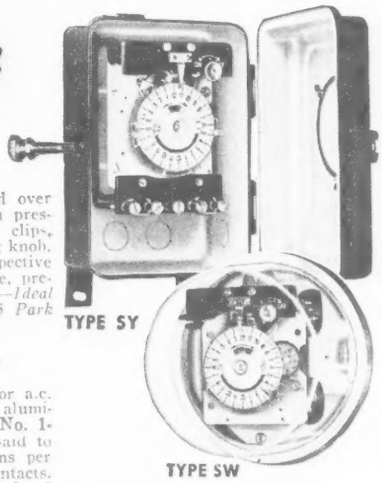
COMMUTATOR AND SLIP RING GRINDER SUPPORT

TYPE O.E. attached to motor so resurfacing element is on rigid and inflexible base between brush-holders; allows resurfacing without dismantling brush-holders or rigging. Type T.O. for attaching to bus yoke and bearing pedestal. W for mounting grinders on larger exciters, motors and generators. Attaches to main frame of machine. Universal type attaches to main housing and bearing support. Plate type for smaller units attached to end bell of motor. Bulletin GB-735. — *Ideal Commutator Dresser Co., Sycamore, Ill.*

SMALL MERCURY SWITCH

CONSISTS of two shallow chrome-steel cups about ¾ in. in diameter, sealed together with strip of lead glass. Separating cups is disk of ceramic material with small hole near edge. Compartment contains about four grams of mercury and filled with hydrogen at about atmospheric pressure and sealed off by welding. In "off" position hole in ceramic disk is above line of inclosed mercury. When rotated 20 deg., switch assumes position where mercury can flow through hole, thus establishing contacts between cups. Hydrogen used as cooling agent and to quench arc.—*General Electric Co., Schenectady, N. Y.*



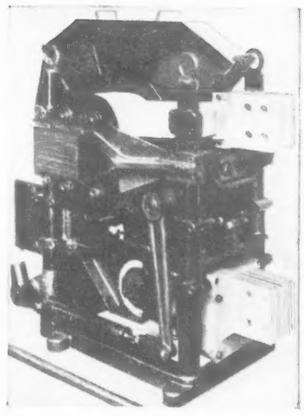


TIME SWITCHES

SYNCHRONOUS-MOTOR "Sauter" switches in 4- or 30-amp. capacity for 110 or 220 volts. Both will control almost any type of a.c. circuit operated on a predetermined-time basis. Plain or astronomic dials. Vernier time adjustments make it possible to set switches within ½ min. SW designed for mounting in standard meter socket, is frequently used for off-peak water heating and 2-rate metering control. SY has all-metal housing.—*R. W. Cramer Co., 67 Irving Place, New York, N. Y.*

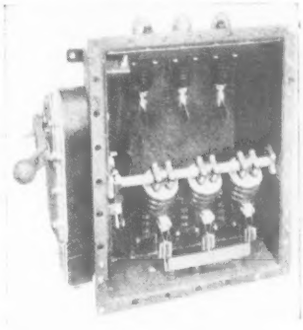
CIRCUIT BREAKER

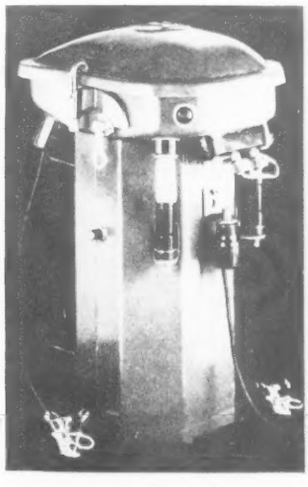
TYPE OH high-speed breaker has maximum continuous rating of 10,000 amp. at 600 or 1500 volts. Four hand-drawn copper contacts covered with blocks of silver are sprung separately to make up moving contact. Opening force of 10,000 lb. produced by two springs in compression, one within the other in a cylinder. Overload mechanism responds to plain overload and rate of rise so that breaker trips below calibration setting on short circuit with rapid rate of rise. On test breaker opened short circuit rising at 9,000,000 amp. per sec. in 0.0063 sec. Bulletin 436.—*I-T-E Circuit Breaker Co., 19th & Hamilton Sts., Philadelphia, Pa.*



3-POSITION SWITCH UNIT

OIL-Immersed 7.5 kv., for mounting on or near transformer for sectionalizing from line in network or radial systems. Non-magnetic pipes require an electric current. Will also determine depth of pipe.—*General Electric Co., Schenectady, N. Y.*



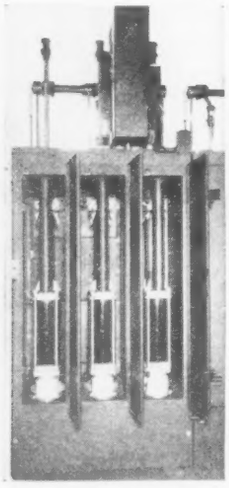


SELF-PROTECTING TRANSFORMER

DISTRIBUTION unit withstands lightning, prevents burnouts from short circuits or overload. Has links in primary winding to protect against feeder outage due to internal winding fault. De-ion gaps furnish lightning protection and internally-mounted thermally-operated circuit breaker in secondary circuit gives visual signal when temperature approaches burnout zone, and removes transformer when in danger. Type CSP from 1½ to 50 kva., 2,400 to 13,800 volts, 60-cycle.—*Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa.*

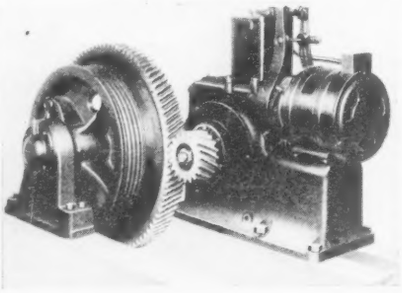
STEEL CUBICLES

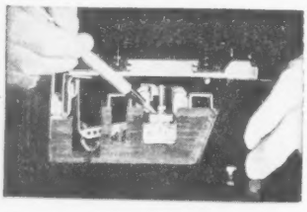
For Type FH oil circuit breakers to replace masonry cells and bus structures, feature simplicity of installation and high salvage value. Shipped completely assembled. Mechanical and electrical interlocks available.—*General Electric Co., Schenectady, N. Y.*



FREIGHT ELEVATOR

External-geared, traction elevator machine for light freight has large-diameter, extended, wormshaft which carries motor armature and brake pulley. Semi-steel, 1-piece, external gear.—*Otis Elevator Co., 260 11th Ave., New York, N. Y.*





MULTI-BREAKER LOAD CENTER

Each contact can interrupt 5,000 amp. at 115 volts, 60 cycles, without objectionable noise or flash. Unit is a low-priced substitute for 115/230-volt a.c. fuse and switch combinations and conventional individual a.c. circuit breakers having branch circuits from 15 to 35 amp. Illustrated is a close-up of the contact mechanism of one pull, exposing common contact in center.—*Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa.*

INDOOR OIL BREAKERS

Station-type FZ-210 has has interrupting devices called "Ruptors" to give quick clearing of short circuits along with low arc energy, low pressure and minimum oil deterioration. Inclosed, low-inertia, high-speed mechanism, internal oil-type shock absorbers, silverplated contacts, oil and gas separators and Bakelain bushings. Interrupting rating 250,000 kva., for 600, 1,200 and 2,000 amp., at 15 kv. Cell mounting (truck or platen) or on framework.—*Condit Electrical Mfg. Corp., Boston, Mass.*

LINESTARTERS

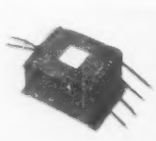
De-ion non-reversing linestarters in four sizes from 25 to 150 amp. used for across-the-line starting of squirrel-cage induction motors and as primary switches for wound-rotor induction motors. Compact, accessible, dependable. Vertical operation of magnets to prevent accidental closing of contacts due to mechanical shock or tilting. Bi-metal thermal overload relay.—*Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa.*

PORTABLE CABLE ACCESSORIES

High-voltage couplers, 100 amp., adapted for G.E. 2,500-, 3,500- and 5,000-volt, Types SH and G, portable cable. Shielding tapes or ground conductors can be brought out of coupler socket for grounding. Malleable-iron socket and plug have covers to keep out dirt and moisture.—*General Electric Co., Schenectady, N. Y.*

SIGNALING TRANSFORMERS

For general application where low-voltage power supply is required. Range of volt-ampere capacities and secondary voltage taps. Core and windings specially impregnated and sealed in heavy steel case. Connected to power lines continuously with low power loss.—*Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa.*



LINE STARTER

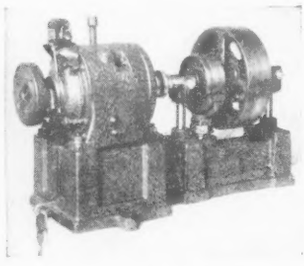
De-ion starter for across-the-line starting of single and polyphase squirrel-cage induction motors may be used as primary switch for wound-rotor induction motors. Thermostat-disk overload relay has inverse time characteristic to prevent shutdown from temporary overload.—*Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa.*

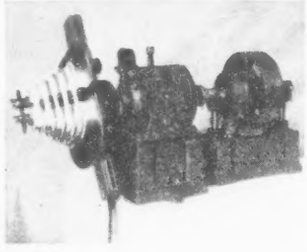
A.C. AUTOMATIC STARTER

For remote operation of 7½ to 25-hp. a.c. motors. Accessible for inspection, vertical closing, compactness. Replaceable units include magnet assembly, stationary or moving contacts and thermal relays. Called Type T, Class 8536. Line-voltage type, can be used to start polyphase squirrel-cage motors directly across line at full voltage. Sizes for motors from 7½ hp. at 110 volts to 25 hp., 440 volts, 550 volts and 600 volts. Units for single-phase motors from 3 hp. at 110 volts to 7½ hp. at 220. Illustrated is a close-up of the mechanism removed from cabinet with its supporting plate, with one moving contact slipped out of its clips. Two or more push-button stations, limit switches or other mechanisms can be used, and two or more units can be interlocked electrically for sequence operation. Liquid-level, pressure, and heat-regulating devices can be supplied with a starter and automatic motor control. Bulletin 132.—*Square-D Co., Industrial Controller Division, Milwaukee, Wis.*

COIL-WINDER DRIVE

Output speed adjustable by foot lever while running. Automatic counter on front records revolutions of winding head, irrespective of direction of rotation. Asbestos-lined brake holds wire under tension and brings winding head to complete stop when foot lever is released. Driven from either lineshaft or by separate motor. Does not require special variable speed motor. Input and output speeds 1,100 and 200 r.p.m. Drive pulley 8 in. in diameter with 2½-in. crown face. Power ½ hp.—*Ideal Commutator Dresser Co., 1025 Park Ave., Sycamore, Ill.*



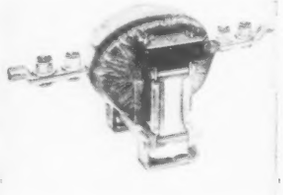


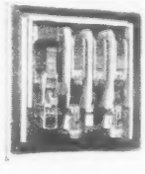
CONCENTRIC COIL-WINDING HEAD

Winds single-phase motor coils in gangs or groups up to six in a nest in all sizes and shapes, connected in series so that they can be removed together and inserted in stator without series soldering.—*Ideal Commutator Dresser Co., 1025 Park Ave., Sycamore, Ill.*

SECONDARY TERMINAL BLOCK

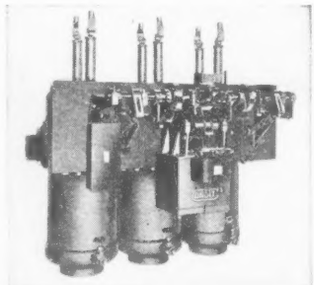
For current transformers. Has conducting parts embedded in molded phenolic insulation. Short-circuiting strap manually operated. Cover cannot be removed without disturbing electrical connections, and cannot be seated in position while secondary is short-circuited. Separate terminal for meter connection.—*Allis-Chalmers Mfg. Co., Milwaukee, Wis.*

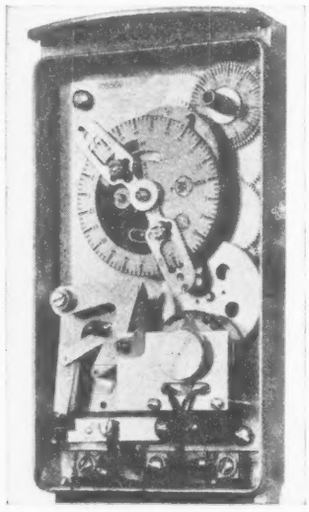




CIRCUIT BREAKER

Type DZ-40, 100,000-kva. Interrupting capacity, indoor oil circuit breaker is equipped with Ruptors. Low arc energy, low pressure and minimum oil deterioration. Other features are: inclosed, high speed mechanism, internal shock absorbers, silvered contacts, oil and gas separator and Bakelain bushings. Furnished for 600 and 1200 amp. at 15 kv. and 2000 amp. at 7.5 kv.—*Condit Elect. Mfg. Corp., Boston, Mass.*





ASTRONOMICAL TIME SWITCH

Synchronous-motor driven. Calendar dial driven by 600-r.p.m. hysteresis motor. Calendar dial, to which on-and-off operating arms are attached, makes one revolution per day. Cams behind calendar dial control position of on-and-off arm, and make one revolution per year.—*Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa.*

TRANSFER CONTROL SWITCHES

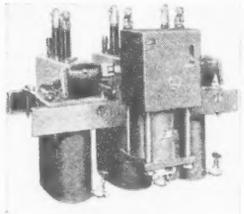
Type SB-1 switches now have electrically separate stationary contacts, large escutcheon, water and oil-tight housing, and removable handles. Water in oil-tight case is in non-corrodible metal housing with suitable gasket. Three sizes, 1 to 4 stages, 5 to 8 stages, and 9 to 12 stages. All can be adapted for use in explosive atmospheres. Key and slot to prevent removal of handle, unless switch is in proper position.—*General Electric Co., Schenectady, N. Y.*

AIR CIRCUIT BREAKER

Type AE-1 is adapted to auxiliary service, or for heavy duty where many opening and closing operations are required. 20,000-amp. interrupting rating and for operation on circuits of 250 volts and 600 volts a.c. at 15 to 600 amp. Main contacts silver-to-silver; arcing contacts special alloy. Double and triple-pole units available. Mechanism electrically operated, trip-free, and latched-in with solenoid suitable for either a.c. or d.c., depending on rating. With pullbox 19x21x21 in.; without, 9-in. depth.—*General Electric Co., Schenectady, N. Y.*

OIL CIRCUIT BREAKER

For interrupting from 100,000 to 250,000 kva. at 15,000 volts with a separate tank for each phase, these Type FK-158A, B and C oil-blast breakers are available in 1, 2, 3 and 4-pole units, with trip-free electrically or manually operated mechanisms. Elliptical reinforced steel-plate tank. Herkolite bushings. Type 158A has main contacts of silver-to-silver line pressure type with butt-type copper facing contacts, while Types B and C have main contacts of wedge-and-finger type.—*General Electric Co., Schenectady, N. Y.*

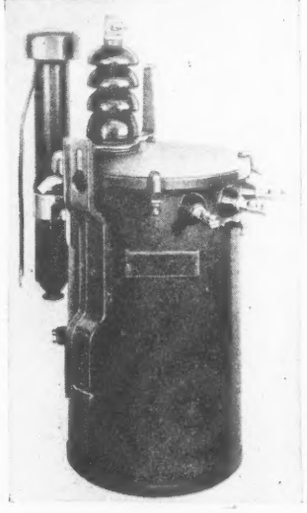


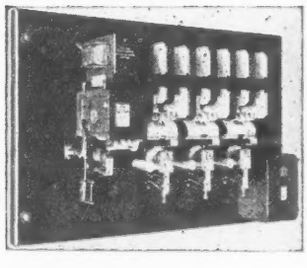
BUS SUPPORT

For insulating and supporting bus-bars on which very high short-circuit stresses may occur. Insulators interchangeable, and clamps are roller type to permit bus expansion.—*Delta-Star Electric Co., Chicago, Ill.*

DISTRIBUTION TRANSFORMERS

Various commercial voltages and 1½ to 10 kva. Separately-wound high- and low-voltage coils. High-voltage winding on sectionalized spool can be slipped off helical low-voltage winding. Can be bolted to pole or hung on conventional hooks. One or two primary bushings and provision for mounting surge diverters.—*Allis-Chalmers Mfg. Co., Milwaukee, Wis.*



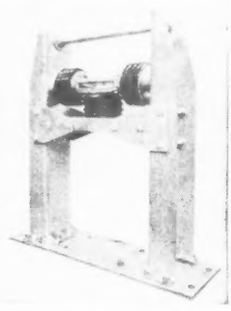


CIRCUIT BREAKERS FOR AUXILIARIES

Solenoid-operated, Type K, circuit breakers with high interrupting capacity, combine contactor and motor-starting characteristics. Latched-in type; do not drop out on loss of voltage. Trip-free closing mechanism. 2- or 3-wire, momentary or maintained contact control.—*I-T-E Circuit Breaker Co., 19th & Hamilton Sts., Philadelphia, Pa.*

SAFETY BELT

"Hy-tensil" gum-impregnated, laminated, moisture-proof fabric has 6,500 lb. tensile strength. Moisture-proof and highly resistant to snagging and cutting.—*American Allsafe Co., Inc., 210 Franklin St., Buffalo, N. Y.*

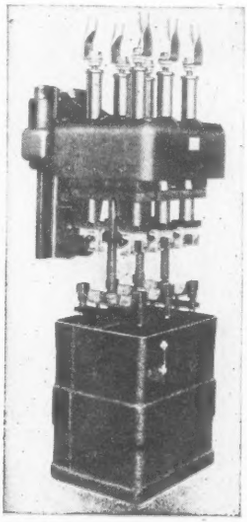


COMMUTATOR SLOTTER

Swiveled joint for ease of handling with bit at any angle. Head circular, opposite faces having notches locked by screw to hold blade at desired angle. One end of tool bit hardened and sharpened for "V" cutting, other for "U" slots. Head, stem and handle bronze. Handle hollow for balance, grooved for grip. Bulletin. —*Ideal Commutator Dresser Co., 1025 Park Ave., Sycamore, Ill.*

50,000-KVA. BREAKER

Indoor oil circuit breaker, Type DX-20, has high-speed, inclosed mechanism, all poles in one tank, Bakelain bushings, oil and gas separator, heavy arcing contacts of large thermal absorption capacity. Furnished for 600 amp. at 15 kv., 1,200 amp. at 7.5 kv., and 2,000 amp. at 5 kv. Manually, solenoid- or motor-operated.—*Condit Electric Mfg. Corp., Boston, Mass.*

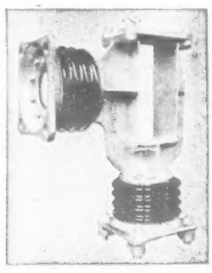


RATIO DIFFERENTIAL RELAY

Type HA for a.c. apparatus has operating time of one cycle. Generator and motor relay operate on internal troubles with 5% of smaller secondary current without tripping on heavy overloads or on external faults. Provided with taps to operate on unbalance equal to 5, 10 or 20% of smaller secondary current. Relay for protection of two winding transformers will operate on fixed differential of 25%. Tripping suppressor prevents operation on transformer magnetizing-current inrushes.—*Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa.*

BUS SUPPORT

Heavy-duty, 7.5-kv. bus support to carry eight 8x¼-in. copper bars. Lower insulator on steel I-beam, side-supporting insulator on concrete wall. Supports have rollers and spring spacers.—*Delta-Star Electric Co., 2400 Block, Fulton St., Chicago, Ill.*



DISCONNECT SWITCH

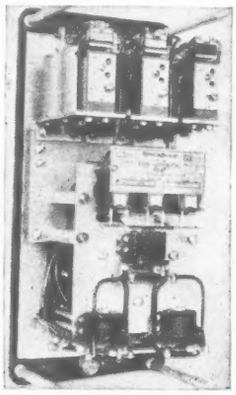
CJH-14 indoor, may be mounted either on flat surfaces or on pipe. Copper tongue-type contacts bridged by floating 2-section blade with automatic lock. Terminal lugs are clamping, solderless type. Ratings 7.5 to 34.5 kv.—*Delta-Star Electric Co., Chicago, Ill.*

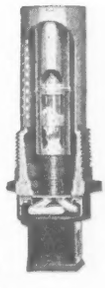
OUT-OF-STEP RELAY

Prevents continued operation of synchronous machines out of synchronism with connected system, or separates large interconnected systems at a specific location in event of an out-of-step or unstable condition between sources of power on both sides. Consists of instantaneous overcurrent unit, single-phase power directional unit, an auxiliary unit to increase operating speed, notching devices and time-delay element for resetting notching device.—*General Electric Co., Schenectady, N. Y.*

PF CORRECTION CAPACITORS

Box-type power-factor correction capacitors are compact, flexible, easy to install. Can be mounted on ceiling, wall or floor in single units or combinations up to 100 kva. Bulletin. —*Power Factor Division, Cornell-Dubilier Corp., So. Plainfield, N. J.*



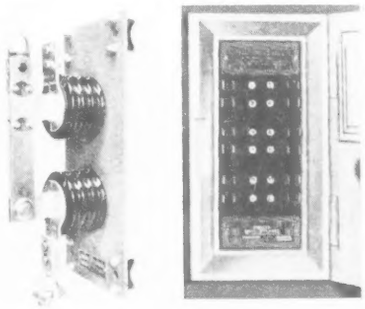


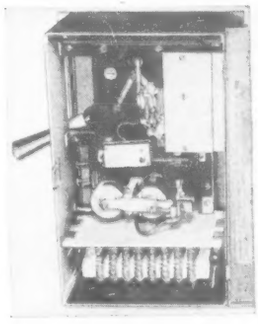
FLOAT-OPERATED SWITCH

For control of liquid levels, this switch can be built into boilers or equipped with float chamber for attachment to vats, tanks or reservoirs by means of equalizing pipes. Working mechanism consists of mercury switch inside float which is attached to head by flexible metallic bellows.—*McDonnell & Miller, Wrigley Bldg., Chicago, Ill.*

MULTI-BREAKER PANELBOARD

Lighting panelboard utilizes Multi-breaker unit. Low cost, compact—boxes 15 in. wide and 4 in. deep. Trims in color with chromium-plated hardware. Boxes galvanized, with bottom and top knockouts. 4 to 40 circuits in 2-circuit groupings for 115, 115/230 volts a.c. Mains for single-phase 3-wire solid neutral or 3-phase 4-wire. Single-pole branches for 15, 20, 25 or 50 amp. Bulletin—*Square D Co., Detroit, Mich.*





D. C. MOTOR STARTER

Type DRT automatic starter for shunt or compound-wound, 250 to 600-volt, d.c. motors, has resistance element of continuous wire wound on asbestos form. Circuit breaker set for 25% overloads for 3 min.—*Ohio Brass Co., Mansfield, Ohio.*

MANUAL OPERATING LEVER

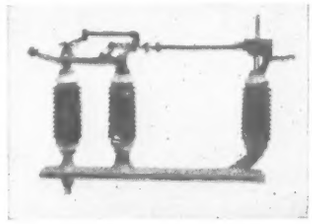
Type HC-2 for use on manually-operated Type FK-42 oil-blast circuit breakers for panel or remote mounting. Trip-free throughout stroke and has toggles so designed that breakers are easy to close. Trip coils interchangeable for all breakers using Types HC-2 and HA-2 levers. —*General Electric Co., Schenectady, N. Y.*

OIL CIRCUIT-BREAKER RECLOSER

15-amp. Type FP-19 oil circuit-breaker recloser has been added to line. Operates on oil-blast principle. Automatic and self-resetting.—*General Electric Co., Schenectady, N. Y.*

UNIVERSAL VERTICAL-BREAK DISCONNECT

Post insulators have cantilever strengths of 2,000 lb., torsional of 12,000-in.-lb. Type AAB-139, 34.5-kv., 600-amp., switch mounts upright, vertical or inverted. Self-aligning contacts are medium-pressure type, wiping clean with each operation, yet fully closed when switch is open.—*Delta Star Electric Co., Chicago, Ill.*



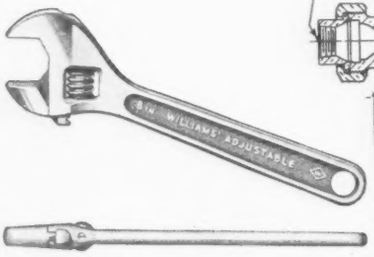
MISCELLANEOUS EQUIPMENT

HIGH-TEMP. STEEL

"SILMO" has about twice strength of carbon steel and oxidation resistance near 4-6% Cr-Mo steel between 1,000 to 1,200 deg. F. Bulletin.—*Timken Steel & Tube Co., Canton, Ohio.*

SOFT-FACED HAMMERS

REPLACEABLE tips are tough, amber-colored composition that does not chip, shatter, or break. Hickory handle. Three weights: 1½ oz., ½ lb., and 1 lb.—*Bonney Forge & Tool Works, Allentown, Pa.*



ADJUSTABLE WRENCHES

SQUARE shoulders on movable-jaw shanks to overcome wedging and spreading and provide positive bearing. "Adjustable" unit drop-forged from special carbon steel. "Superjustable" wrenches forged from chrome-alloy steel. Both types in five sizes, 4, 6, 8, 10 and 12 in. Bulletin.—*J. H. Williams & Co.*, 75 *Spring St., New York, N. Y.*

ELECTRIC MARKER

MOTOR-OPERATED, portable electric marker "writes" on metallic and non-metallic materials. Handsize, 6¾ in. long, weighs 2 lb. and is handled as a pencil or crayon. 6-ft. cord with switch and plug for 110-volt, 60-cycle and other standard outlets. Consumes about 75 watts.—*Ideal Commutator Dresser Co.*, 1025 *Park Ave., Sycamore, Ill.*

INDUSTRIAL CLEANER

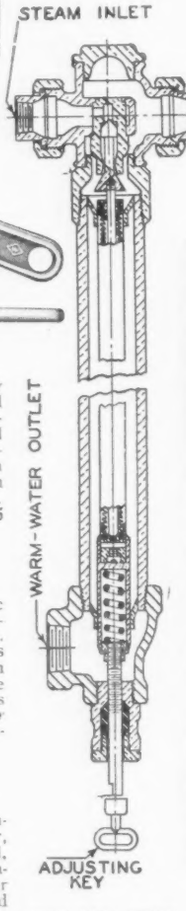
MODEL E "Hypressure Jenny" combines cleaning with mixture of vapor, hot water, soap or selected chemical, and pressure. Unit, fully self-contained, carries own fuel tank, water and solution tanks, oil burner and vapor generator.—*Homestead Valve Mfg. Co., Coraopolis, Pa.*

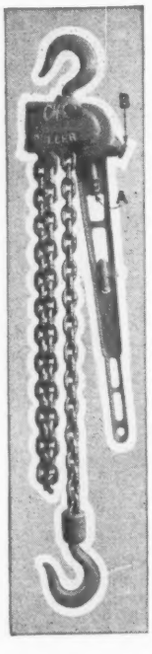
IRREGULAR CURVE

LEAD-CORE adjustable irregular curve for draftsmen has metal-impregnated exterior rubber surface against which pen or pencil slides freely. Designed with low drawing edge on one side and center drawing edge on other. Corrugated top and bottom for easy holding.—*Wade Instrument Co.*, 2275 *Brooklyn Station, Cleveland, Ohio.*

STEAM AND WATER MIXER

COMPACT, self-operated. Produces water at any desired temperature directly at point of use by mixing steam and water. Incorporates 3-way valve, water injector and temperature regulator. Silent operation. Small sizes use single-seated valves, large sizes, double-seated.—*Sarco Co., Inc.*, 183 *Madison Ave., New York, N. Y.*





PULLING TOOL

PULLS at any angle ¾ or 1½ tons. Gear reduction allows 43 lb. on rachet handle to pull ¾ ton. ¾-ton size weighs 17 lbs., with minimum distance between hooks of 9 in. Collapsible handle. "Herc-Alloy" steel chain.—*Chisholm-Moore Corp., Tonawanda, N. Y.*

GASKET CUTTER

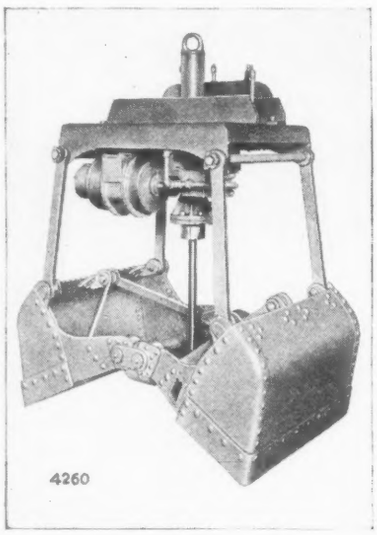
WILL cut gaskets from asbestos, superheat sheets, rubber sheet packing, cloth-inserted sheet packing, felt, cork, cardboard, cloth, duck, rubber, etc. Furnished with six double-edged cutting blades any thickness from 1/100 to 5/8 in. Unit will cut gaskets from 1 to 36 in. diam.—*Allpax Co., Inc., Mamaroneck, N. Y.*

FOAM-MAKING NOZZLE

"PHOMAIRE" play pipe makes foam mechanically for fighting flammable-liquid fires. ¾ to 2½-in. hose. Foam-making solution (from operator's hip pack) and air automatically drawn into water stream in proper proportions. One gallon of solution makes 350 gal. of foam.—*Pyrene Mfg. Co., Newark, N. J.*

ELECTRIC-HYDRAULIC CLAMSHELL BUCKET

MOTOR-DRIVEN fluid pump controls hydraulic ram on bucket. Opening and closing accomplished by electric motor controlled from operator's cab. No closing line or winding drum required.—*Hayward Co.*, 50 *Church St., New York, N. Y.*

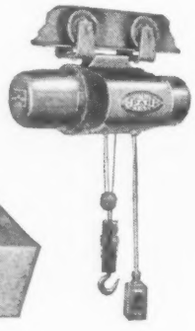


AIR HOSE

"HIPRESS" has inner carcass of four plies of specially woven duck and outside of tight braid of high-tensile cords. Tube is of oil- and heat-resisting rubber, while rubber cover is compounded to withstand abrasion and abuse. Three sizes, ½, ¾ and 1 in. in 500-ft. lengths. — *Mechanical Rubber Goods Div., B. F. Goodrich Co., Akron, Ohio.*

ELECTRIC HOIST

"ZIP-LIFTS," capacities 250 to 500 lb., for "spot handling" work. Welded. ¼-ton model weighs 100 lb. Hoisting speeds up to 32 ft. per min. Controlled by pushbutton or pendant rope. With or without trolley.—*Harnischfeger Corp., Milwaukee, Wis.*

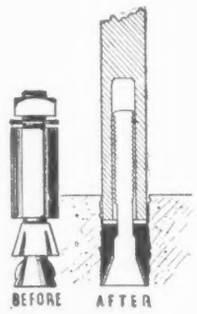


PLASTIC PACKING

"SUPER-SEAL" resilient, dry-graphite lubricated packing. New alloy in fine particles carried in long fibre asbestos, covered and saturated with special high-temperature binder containing flake graphite. All popular sizes and shapes.—*Crane Packing Co.*, 1801 *Cuyler Ave., Chicago, Ill.*

EXPANSION BOLT

STEEL bolt has thin steel cone jacket under head with lead jacket outside. Driven down with application tool to expand steel cone over bolt head, thus filling space between head and wall of hole, and preventing lead from flowing past bolt head. Lead jacket expands and flows over steel cone, filling hole around bolt shank. "Life-time" expansion bolt, sizes ¼ to ½-in. diameter, and 1½ to 8 in. long. Plain, cadmium or hot-galvanized finish. Special sizes on order.—*Chicago Expansion Bolt Co., Room* 691, 126 *South Clinton St., Chicago, Ill.*



HEAVY-DUTY SOCKETS

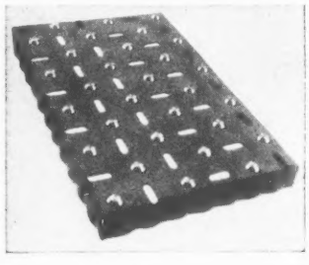
THREE additional sizes. 1-in. square-drive extra heavy-duty sockets. X72 has 2¼-in. hexagon opening, while X94 and X100 have hexagon openings of 2 15/16 and 3⅛ in.—*Bonney Forge & Tool Works, Allentown, Pa.*

ALLOY STEELS

"USS CARRILLOY" is new trade designation to show trademark for entire group of Carnegie-Illinois alloy steels.—*Carnegie-Illinois Steel Corp., Pittsburgh, Pa.*

STEEL PAVING PLATES

PERMANENT and protective surfacing for concrete floors and paving, anchored on surface of concrete slabs. Two kinds of ⅛-in. rolled steel for roadways and plant floors, have crimped sides perpendicular to surface. Floor type has smooth surface with long-shank anchorage studs, with flat heads, fastening through countersunk holes, making them flush with top surface. Standard size is 12 by 18 in., with 1½-in. sides.—*Bethlehem Steel Co., Bethlehem, Pa.*



CLEANING UNIT

MODEL G, "Hypressure Jenny," sprays combination of water vapor, hot water and cleaning chemicals at 50 to 150 lb. per sq. in. Vertical-spiral-parallel-coil vapor generator controlled by automatic switch. Burns kerosene or light furnace oil. Stationary or portable.—*Homestead Valve Mfg. Co., Coraopolis, Pa.*

INDUCED-DRAFT COOLING TOWER

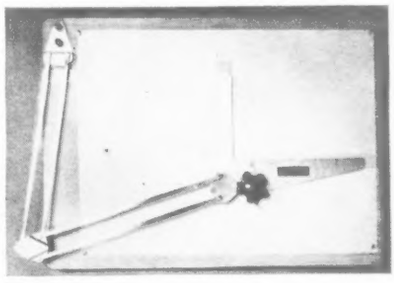
TYPE K-400 galvanized-steel tower is fitted with two 60-in. diameter fans driven by individual 3-hp. motors at about 550 r.p.m., with displacement of 58,000 c.f.m. and capacity of 400 g.p.m. Fans in uppermost portion of tower draw incoming air through open louvre sections at tower base. Spray eliminators directly under fan assembly.—*Binks Mfg. Co., 3114 Carroll Ave., Chicago, Ill.*

ELECTRIC DRILLS

THREE models are "Special Duty" ¼-in., and "Defender" ¼- and ½-in. drills. Three-jaw geared chuck and key. Double-pole momentary contact switch with lock for continuous operation inclosed in Bakelite. Model 40, special-duty tool, for drilling light metals.—*Skilsaw, Inc., 3345 Elston Ave., Chicago, Ill.*

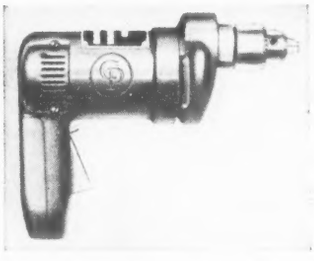
PROTECTIVE COATING

"COPPERCOTE" is special vehicle containing minute flakes of metallic copper. When applied, reaction between vehicle and copper creates dendritic, close-knit, hard coating which protects surfaces beneath from corrosion. Non-conducting. Fire-resistant. —*American Coppercote, Inc., 480 Lexington Ave., New York, N. Y.*



DRAFTING MACHINE

"WRIGRAPH" Model E-272 streamlined drafting machine mounted on 22-30-in. cleated, white-pine board. Hand-assembled parallel mechanism has all-steel, nickel-plated parts on phosphor-bronze bearings. Graduated L-square blade of pyroxlin riveted to light-weight aluminum stiffner.—*L. G. Wright, Inc., 5713-37 Euclid Ave., Cleveland, Ohio.*



UNIVERSAL ELECTRIC DRILL

"MIDGET" No. 801 CP unit for 3/16-in. drilling. Over-all length 7 1/16 in., net weight 2 lb., 1 oz. 2-pole switch with trigger and lock. Companion screw driver and nut runner. Speed, loaded, 1,500 to 2,100 r.p.m. —*Chicago Pneumatic Tool Co., 6 East 44th St., New York, N. Y.*

PACKING CONDENSERS

FLEXIBLE-SHAFT tool inserts packing lace in a continuous coil, and tamps it automatically. Tool sleeve describes a rotary motion, tamping three taps per revolution, adjustable in hardness. American agent, *Dr. F. Loewenberg, 10 East 40th St., New York.*

DRAIN RACK

24-IN. high "Rockerack" permits one man to place barrels or drums for draining. Gentle rocker arc plus new automatic floor lock effectively locks rack in draining position. For either 500 or 750-lb. containers, in either plain or caster type. All steel.—*Barret-Cravens Co., 3255 W. 30th St., Chicago, Ill.*

REVERSIBLE RATCHET WRENCH

"SUPERECTOR" has quadruple pawls. Five sizes, 24 to 48 in. Both hex and square sockets with hole extending clear through. Openings 1 1/16 to 4⅝ in.—*J. H. Williams & Co., 75 Spring St., New York, N. Y.*

HIGH-TEMPERATURE STEEL

SICROMO 1, 2, 3 and 5 contain 0.50% molybdenum to increase creep strength. High silicon content develops oxidation resistance, and chromium in proportion to numbers of alloy provides corrosion resistance. Nos. 1, 2 and 3 for high-temperature applications with low to medium oxidation and corrosion resistance. No. 5 for severe corrosion and oxidation with low cost.—*Timken Steel & Tube Co., Canton, Ohio.*

ELECTROPLATED TUNGSTEN

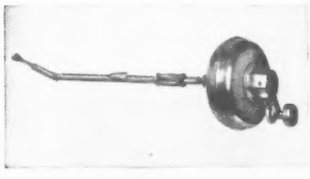
ELECTRODEPOSITION process permits tungsten to be deposited in homogeneous combination with one or more metals through same electrolytic solution. Optimum tungsten range may be from 35 to 50%, if desired. *Tungsten Electrodeposit Corp., Barr Bldg., Washington, D. C.*

TELEPHONE BOOTH

ABSORBS extraneous sounds. Interior faced with perforated metal sheets backed with balsam wool. Washable metal facing. No door necessary.—*Burgess Battery Co., Madison, Wis.*

DRAIN AUGER

FOR removing obstructions from floor drains, oil lines, water lines, process lines, goosenecks, elbows, etc. Flexible tube.—*Sanitation Tool Mfg. Co., Chicago, Ill.*



SIDE-SHIELD GOGGLE

F-3105 Ful-Vue has high-up end pieces, self-adjusting nose pads, 6-curve "super-armorplate" lenses and side shields. Wire mesh screens noncorrosive and easily cleaned. Noncorrosive frame. Bulletin.—*American Optical Co., Boston, Mass.*

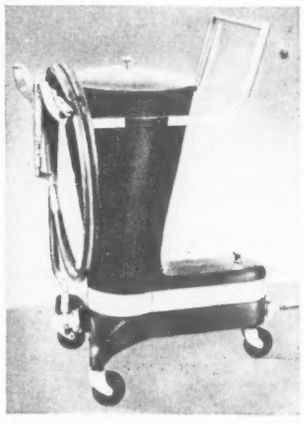
SHIM-STOCK

RACK keeps all sizes of 2x9 laminated brass and thin shim stock. Amount of stock required pulled through slots in cartons and cut off. —*Laminated Shim Co., New York, N. Y.*

OIL FILTERS, PURIFIERS, LUBRICATORS, LUBRICANTS

LUBRICATING GUN

"ROCK CRUSHER" has twin guns (electric and air-operated) with capacities of 40 lb. 10-ft. hose assemblies. Air-operated (RA-40) delivers 11 to 18 oz. of lubricant per min. at 150 to 200 lb. air pressure. Electric (RL-40), with universal motor, develops approximately 5,000 lb. pressure, delivering 9 oz. of lubricant per min.—*Alemite Division of Stewart-Warner Corp., 1878 Diversey Pkway, Chicago, Ill.*

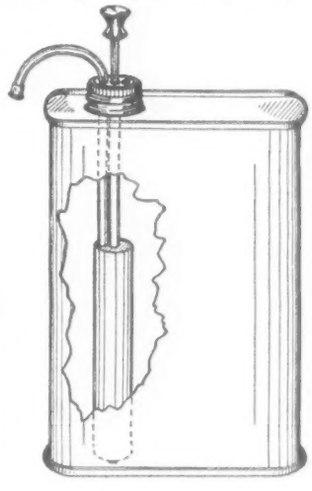


OIL CUPS

"THERMATIC" cup supplies constant, slow flow of oil due to normal increase in temperature of running bearings. Rise of 1.8 deg. F. causes flow. Supply replenished from cup reservoir by gravity. Base inlet admits sufficient air to maintain pressure. 80-mesh filter screen at bottom of reservoir. Microflow cup supplies continuous flow in small adjustable quantities.—*Alemite Division of Stewart-Warner Corp., 1826 Diversey Pkway, Chicago, Ill.*

MEASURING PUMP

FOR measuring out small quantities of oil, glycerine and other liquids, double-acting pump delivers accurately ½ or 1 oz. with each stroke. —*V. R. Hall Products Co., 9304 Amesbury Ave., Cleveland, Ohio.*



UNIVERSAL OILER

"Au" Type "Oilit" allows adjustments of oil level in bearings after installation. Combines principle of constant-level lubrication with visible supply.—*National Industrial Products Corp., 1400 West 25th St., Cleveland, Ohio.*

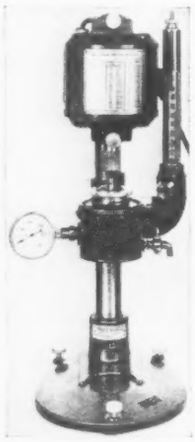
POCKET OILER

Transparent non-breakable reservoir has no-leak refill screw cap, pocket clip and spout similar to fountain pen. Steel point attached to plunger ejects 1/10 drop each stroke.—*V. R. Hall Products Co., 9304 Amesbury Ave., Cleveland, Ohio.*

PIPING, VALVES AND FITTINGS

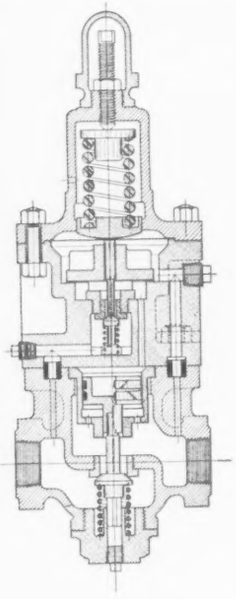
WATER-PRESSURE REGULATOR AND SOLENOID VALVE

For applications where it is necessary to control flow of water or air electrically and also necessary to control pressure at which fluid is delivered from valve. Combines functions of solenoid-operated stop valve and pressure-regulating valve. Valve includes strainer with large fine-mesh screen. Water enters at *A* when solenoid coil is energized. Plunger is drawn upward off its seat and water flows through the strainer and valve body to *E*. Outlet water pressure maintained by spring setting *C*. Increase in water pressure at *D* causes diaphragm to move upward, throttling valve *B*. Diaphragm floats back and forth in response to fluctuations in supply pressure and thus maintains fixed outlet pressure. Outlet pressures 5 to 50 lb. or higher and maximum water pressure 100 lb. Model DE. Bulletin. Sizes ¼ and ⅜ in. I.P.S. —*General Sales & Products Corp., Cohoes, N. Y.*



TESTING MACHINE

To determine mechanical stability of heavy lubricants, this machine works a definite amount of grease in a plate-shielded size 204 SAE bearing in a grease cup free to turn. Bearing is on spindle-extension of constant-speed, 3450-r.p.m. motor. Temperature of grease is controlled and recorded by dial thermometers. Bulletin.—*Taft-Pierce Mfg. Co., Woonsocket, R. I.*

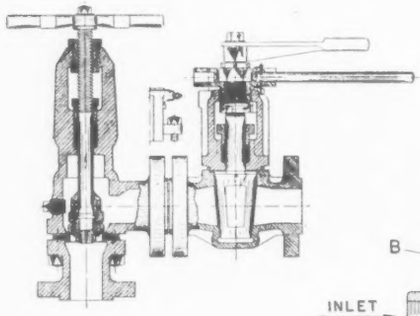


PRESSURE-REDUCING VALVES

Style "A", auxiliary or pilot operated, for steam or air, is self-contained, and will reduce high initial or supply pressure to any reduced or delivery pressure from 1 lb. up to within about 20 lb. of initial pressure. Variations in initial pressure do not interfere with positive operation. Standard construction to 250 lb. and 500 deg. F. Sizes ½ to ¾ in. bronze, 1 in. and larger cast iron. Internal parts bronze, piston rings cast iron for up to 1,000 deg. F. Springs steel. For pressures to 400 lb. and superheated steam of 750 deg. F., bodies extra-heavy cast steel with stainless-steel internal parts, except for ¼- and ¾-in. bodies, which are special alloy.—*Schade Mfg. Co., 2527 N. Bodine St., Philadelphia, Pa.*

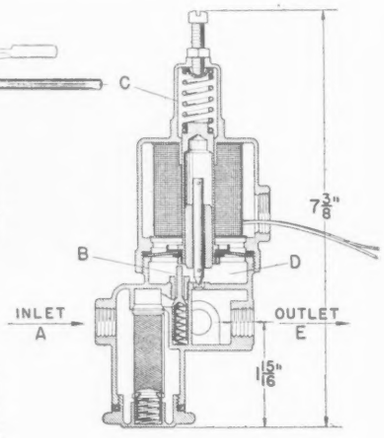
TANDEM BLOW-OFF VALVE

"Atlas" tandem blow-off valve for working steam pressures to 1,800 lb. per sq. in. combines two valves in one forged-steel body 4x4x7 in. Inlet valve is metallic-packed cylindrical rotary type repacked through a feed-screw in its stem. A repacking fitting is provided by which valve can be repacked under pressure, fitting providing positive shut-off while feedscrew is withdrawn for recharging. Auxiliary valve also used for more-frequent, smaller-quantity blowdown. Four sizes 1¼, 1½, 2, 2½ for 250-600 lb. wsp, and three sizes, 1¼, 2, 2½ for 900 to 1,500 lb. —*Clees Valve & Engrg. Co., 90 West St., New York, N. Y.*



PLUG VALVE

Incorporates positive mechanical seating and unseating. Mechanical leverage lifts plug vertically from seat sufficiently to break friction between plug and body and allow free rotation. Plug reseated by same process. Simple lubrication. Valve body streamlined. Pressure range 125 lb. and up, temperature up to and including 750 deg. F. Illustrated is blow-off combination in which new unit is used with regular angle blow-off.—*Homestead Valve Mfg. Co., Coraopolis, Pa.*

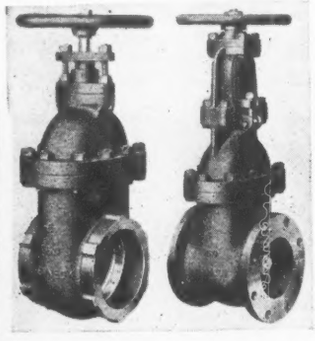


CLAMPS FOR STOPPING LEAKS

Easily applied. Will handle pressures up to 3,000 lb. on steam, hot-water or vapor pipes. Stops leaks in air, gas, steam, vapor, gasoline, oil, chemical, pulp, ammonia, brine and all other pipe lines.—*M. B. Skinner Co., 3796 W. Sample St., South Bend, Ind.*

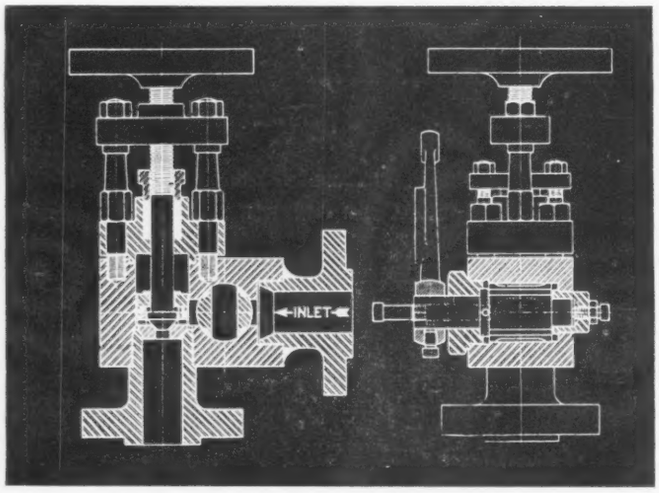
WEDGE-GATE VALVES

Standard iron-body valves of oval section with well-rounded corners, heavy flanges and bolts, and ribbing on flanges of larger flanged-end valves and at yokes and caps of outside screw-and-yoke types. Heavy bronze bushings where stem passes through cast-iron parts, as of yoke cap, packing gland and stuffing box. Disks reinforced with posts, self-draining in any position and reversible and interchangeable. All standard sizes from 1½ to 60 in. for wsp. pressure of 150 lb. and wwp. of 200 lb.—*Kennedy Valve Mfg. Co., Elmira, N. Y.*



PORABLE OIL REFINER

"Luber-finer" continuously removes foreign substances, refines, purifies and decolorizes crankcase oil. Dirty oil first contacts refining clay, then a series of straining and filtering devices.—*Luber-Finer, Inc., 1119 S. Hope St., Los Angeles, Calif.*



AIR-DRYING SYSTEM

For removing water and oil released by condensation in air lines. Includes aftercooler, expeller, automatic drain trap and strainer. Expeller, left of illustration, can also be used alone at end of long compressed-air lines. Drain trap below expeller automatically drains out accumulated moisture and oil from both aftercooler and expeller. Air capacities from 0 to 300 cu. ft. per min., at pressures up to 135 lb. Air-pressure loss less than 1 lb. per 125 lb. Uses 1½-g.p.m.

cooling water for each 100 c.f.m. in multi-stage compression. Slightly more for single-stage. Special units for higher pressure or capacities.—*Ruemelin Mfg. Co., 3860 N. Palmer St., Milwaukee, Wis.*

FORGED-STEEL GLOBE VALVES

For pressures up to 1500 lb. with tongue-and-groove bolted bonnet for high-temperature service. Cone or plug type with valve seat ring and disk heat-treated stainless steel. Renewable. Seat ring removable. 20-page bulletin.—*Hancock Valve Co., Bridgeport, Conn.*

PIPE-THREADING COMPOUND

"Nabico Joint-Seal" for steam, gas or air pipelines at reasonable pressures or preservative dressing for flanges or joint packings.—*National Boiler Improvement Co., Inc., 4100 George Ave., Washington, D. C.*

HEAVY-DUTY THREADER

For all sizes from 2½ to 8⅝ in. Double-action clutch throws directly from low into high, or vice versa, without gear shifting. Driven by 15-hp. motor. Only one set of jaws for full range. Cascade oiling. High-speed steel cutoff, reaming and chamfering tool. Maximum carriage travel 28 in. Will handle pitches of 8, 10, 11½ and 14. No. 8-XHD.—*Oster Mfg. Co., 2057 East 61st Place, Cleveland, Ohio.*

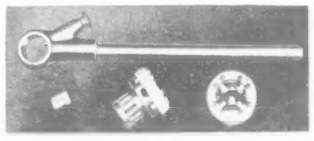
Ventilated handwheel on small sizes. Full-thickness I-beam cast wedge. Horseshoe spindle and wedge connection. Long-thread stuffing box with follower. Parts interchangeable. Bulletin 860.—*Reading, Pratt & Cady Co., Inc., Bridgeport, Conn.*

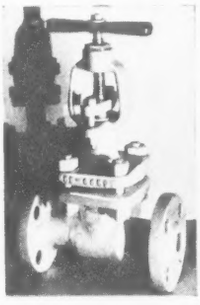
PIPE INSULATION

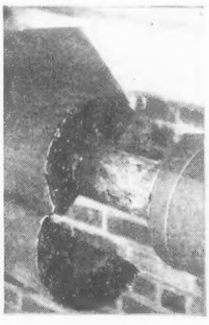
"Apsco" cell-concrete insulation for underground steam and hot-water lines will retain physical strength and shape as well as completely regain insulating value after repeated submergence in water. Made from Portland cement mixed with foam, producing light-weight cellular concrete of 0.3 sp.g. Mixed on job.—*American District Steam Co., North Tonawanda, N. Y.*

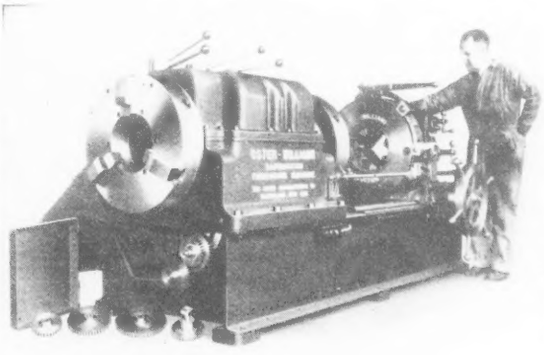
RATCHET THREADER

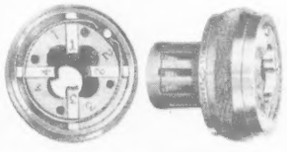
No. 2 open ratchet ⅛- to ¾-in. is a low-cost unit. Dieheads have oil holes and chip clearance and can be inverted for threading close to wall. Dies easily removed for resharpening.—*Beaver Pipe Tools, Inc., Warren, Ohio.*





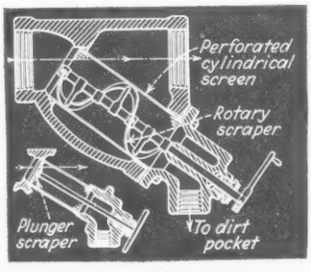






PIPE INSULATION

Cork pipe covering for cold lines is waterproofed Rockwool. Waterproof jacket provides moisture resistance. Fittings insulated with multiple layers of Zerotex waterproofed Rockwool. Each layer sealed with double wrapping of waterproofed sealing tape, and completed with layer of asphalt-base plastic.—*Johns-Manville Corp., 22 East 40th St., New York.*



SELF-CLEANING STRAINERS

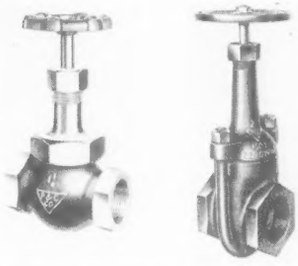
Modification of pipeline strainer is fitted with plunger or rotary scraper within cylindrical screen. Cleaned without removal where flow is continuous.—*Sarco Co., Inc., 183 Madison Ave., New York, N. Y.*

PIPE MACHINE

Model A special will cut, thread, ream and chamfer ⅛- to 2-in. pipe, operate geared tools to cut and thread 2½- to 12-in. pipe, cut off solid round bars or stayrods ¼ to 1 in., and thread bolts and stayrods from ¼ to 2 in. Reversible, standard-base-mounting, 110 or 230 volt, a.c. or d.c. 25 to 60-cycle motor.—*Beaver Pipe Tools, Inc., Warren, Ohio.*

RENEWABLE-DISK VALVES

Fig. 1-A bronze globe and angle valves with standard disk rings have working pressures of 150 lb. for steam, 300 lb. O.W.G., screwed or flanged. ⅛ to 2½ in. pipe size. Disk guides extend all the way to seat. Bevel between body and hub for tightness. Flat seat. Bulletin 941.—*Reading, Pratt & Cady Co., Inc. Bridgeport, Conn.*

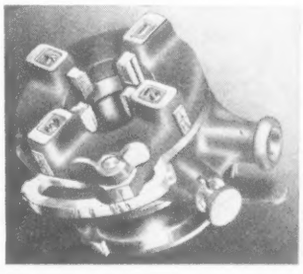


CLIP-GATE VALVE

Fig. 122-C iron-body, round-bonnet valves are available from ½ to 3 in. pipe sizes, either all iron or bronze mounted. Rated at 150 lb. steam or 225-lb. non-shock cold oil, water or gas. Male and female bonnet joint with asbestos gasket, held by U-bolt.

RATCHET

6-R has three sets of dies (¼ and ⅜, ½ and ¾, 1 and 1¼) quickly interchangeable and adjustable for standard or outsize threads. 3-jaw self-centering pipe chuck. Dies above chuck face for chip clearance and ease in oiling. Heavy ratchet and pawl. Malleable iron, rustproofed.—*Beaver Pipe Tools, Warren, Ohio.*



DIAPHRAGM VALVE-MOTOR

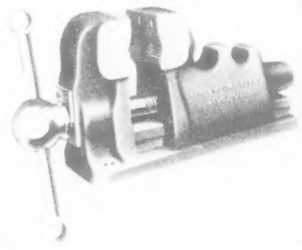
"Motosteel" improved, welded-steel diaphragm valve-motor has larger molded diaphragm, formed impressions in top plate for access of air pressure to diaphragm in starting, and longer and larger diameter spring for greater initial compression and less hysteresis.—*Taylor Instrument Cos., Rochester, N. Y.*

ADJUSTABLE BOLT DIE HEADS

For use with "Toledo" No. 00 ratchet, cadmium plated. Standard bolt threads or over or under adjustment of 1/64 in. by loosening four die-head-cover screws and turning knurled ring.—*Toledo Pipe Threading Machine Co., Toledo, Ohio.*

STEAMFITTER'S VISE

Heavy-duty vise for ⅛ to 6 in. pipe has semi-steel cast base and jaw. Large deeply-checked, tool-steel flat jaw facings and special pipe-grip sections. No 1115 has 5-in. jaw width and weighs 137 lb.—*Athol Machine & Foundry Co., 621 South Kolmer Ave., Chicago, Ill.*

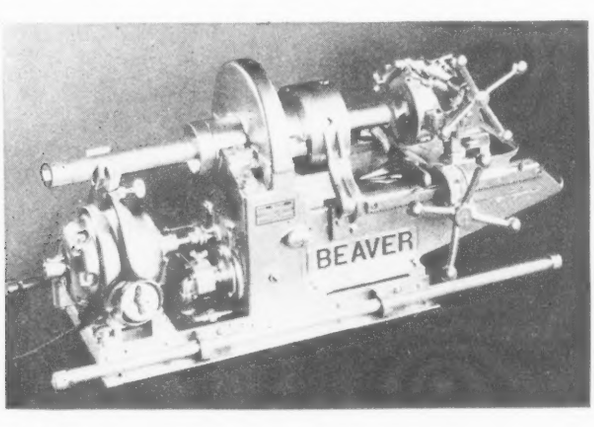


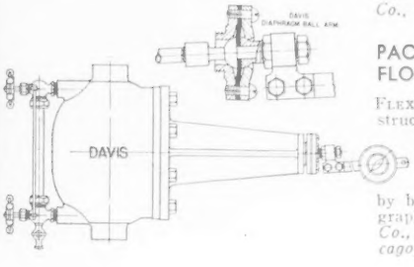
SEAMLESS ALLOY TUBES

B. & W. Croloy 25-20, containing 25% nickel, hot-finished in sizes to 6 in. O. D., cold-drawn in smaller sizes. High oxidation resistance for continuous operation up to 2,100 deg. —*Babcock & Wilcox Tube Co., Beaver Falls, Pa.*

WELDED VALVE SEAT

Seperate ring of Seco metal, threaded to take seat ring, is welded into valve body to resist wire-drawing. Slight leak will not damage threads and, if necessary, seat ring can be taken out, cleaned, and jammed back tight. Bulletin No. 5.—*Spence Eng. Co., Inc., 110 East 42nd St., New York, N. Y.*





OIL-RESISTING PNEUMATIC HOSE

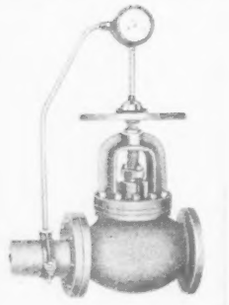
Can be saturated with oil for long periods without harm. Plies are twisted cord impregnated with rubber compound.—*Republic Rubber Co., Youngstown, Ohio*

PACKLESS FLOAT BOX

Flexible-diaphragm ball-joint construction eliminates packing in float boxes for valves, switches, signal or indicator operating purposes. Diaphragm is Duprene synthetic rubber. Thrust carried by ball-joint, outside lubricated with graphite grease.—*Davis Regulator Co., 2540 S. Washtenaw Ave., Chicago, Ill.*

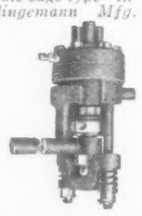
VALVE-POSITION INDICATOR FOR VERTICAL STEMS

MODEL 4-VS Tejax adjustable valve-position indicator shows exact setting and permits easy return to it. Will read as close as 1/100 turn. Small hand counts number of turns while large hand indicates fractions. Dial 3½-in. For valves with handwheels of 6 in. or over. Also Model 2-VS for smaller valves with special handwheel and 2½-in. dial.—*Lefft-Jackson, Inc., Providence, R. I.*



ADJUSTABLE FULCRUM FOR BALANCE VALVES

SELF-ADJUSTING fulcrum provides increasing or decreasing movement of valve disk for fixed movements of lever. Power increased by having fulcrum at shortest point when valve disk is being lifted from seat. Single or double-seated types with or without removable-cage-type interiors.—*Ruggles-Klingemann Mfg. Co., Salem, Mass.*



WASTE-LINE CLEANER

"POWER-TWIST" cleaner is flexible steel rod wound on reel and fed through sleeve and flexible nozzle. Reaches stoppage 50 ft. from opening in 1 in. and larger lines.—*Standard Appliance Corp., 201 Hickory St., Dayton, Ohio.*

HYDRAULIC VALVE *(Left)*

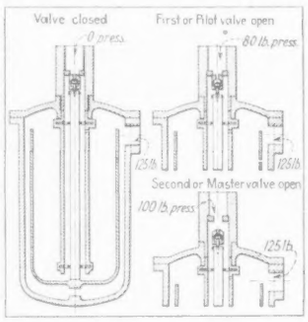
STYLE "H" balanced, flat-disk 2-, 3- and 4-way valves for oil or water up to 5,000-lb. pressure act like differential pistons. Pressure in valve body presses disk down and smaller-area stem up. Two spring adjusting nuts exert required downward pressure on stem through crossbar and ball. Bulletin 236.—*W. H. Nicholson & Co., 12 Oregon St., Wilkes-Barre, Pa.*

VALVES FOR COPPER PIPING *(Left)*

"SOLDER-END" valves for copper lines with up to 150 lb. pressure. Except for ends, same as standard threaded valves. 8-page folder.—*Jenkins Bros., 80 White St., New York, N. Y.*

WASTE-LINE CLEANER (continued)

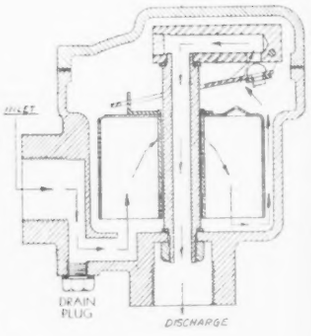
pressure drips up to 450-lb. gage. Either ¼ or ¾-in. screwed or flanged connections. Inverted-bucket and free-floating lever, only moving parts. All interior mechanism stainless steel; valves and seats heat-treated. Body and cap forged of SAE .25 to .30 steel; bolts and nuts Supertemp steel. Wt. 30 lb., 6¾-in. diam., 10¼ in. high. At 450 lb., continuous discharge capacity is 2,500 lb., hot condensate per hr.—*Armstrong Machine Works, 712 Maple St., Three Rivers, Mich.*



MAGNETIC PIPE DETECTOR

SURVEYING compass with adjustable bar magnet for reducing effect of earth's magnetic field is used in locating "missing" pipes. Fixed to compass box on tripod, and turning with it, are two radial fins which serve as magnetic antennae. Detector is sensitive to iron or steel pipe lines, having any magnetic bearing, and at considerable distance. Non-magnetic pipes require an electric current to be passed through them. Will also determine depth of pipe below surface of ground.—*General Electric Co., Schenectady, N. Y.*

STEAM TRAPS



SMALL STEAM TRAP

FOR small capacities "Super-Silverton No. 10" is available for pressures to 25 lb. Bucket 1-piece copper. Working parts stainless steel. No strainer necessary. Inspected, cleaned or disassembled without removing from line.—*V. D. Anderson Co., 1934 W. 96th St., Cleveland, Ohio.*

AIR ELIMINATOR

FOR removing entrained air from cold steam systems. For Super-Silvertop inverted-bucket steam traps; utilizes Spencer Thermostatic Disk. In cold position, disk curves out and away from three large auxiliary air ports on side of inverted bucket. Eliminator remains open until critical temperature is reached, then closes, covering ports. Trap then operates normally.—*V. D. Anderson Co., 1934 West 96th St., Cleveland, Ohio.*

FORGED-STEEL TRAP

No. 312 is a small, relatively low-priced trap to take care of high-

HIGH-CAPACITY TRAP

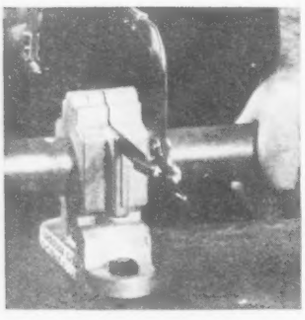
CAPACITY of Type AE steam trap increased 3 to 4 times for given weight. No. 15 weighs 15 lb. and has continuous discharge capacity of 1,400 lb. per hr. at 125 lb. No hinges or levers. Air entering when valves are closed goes through vent into central tube, allowing water in tube to seek its own level, but passing out at beginning of discharge. Working pressures to 200 lb., except for smallest trap, which is 150. Capacities 300 to 18,000 lb. per hr. continuous discharge. Pipe sizes ½ to 2½ in.—*Stickle Steam Specialties Co., Indianapolis, Ind.*

COMBINED THERMOSTATIC AND BUCKET TRAP

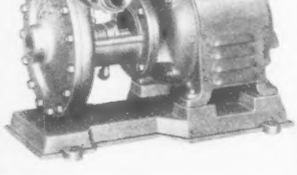
"SUPER-SILVERTOP" combination give complete air elimination even at low pressures. Air is bypassed around water seal. Entrained air causes bellows to contract, opening bypass and passing air direct to return line. Pipe connections up to 1¼ in., capacities to 10,200 lb. at 15 lb. pressure. System pressures from fraction of an ounce to 50 lb.—*V. D. Anderson Co., 1934 W. 96th St., Cleveland, Ohio.*

TUBE-SAWING VISE SET

FOR holding thin-wall tubing for sawing, soldering, etc., this vise consists of base with handle for clamping hinged collars, slotted for saw. Seven sizes of collars for ⅛- to 2-in. diameter pipe and special sizes.—*Trimant Mfg. Co., Inc., 55-71 Amory St., Roxbury (Boston), Mass.*



PUMPS FOR POWER PLANT AND INDUSTRIAL USES

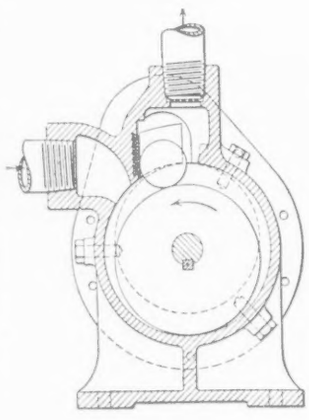


BOILER-FEED PUMP

HANDLES feedwater against either low or high pressure at high temperature. Can be fitted for automatic operation if desired. Sizes up to 3 in.—*Becker Pump Co., Inc., 1447 Park Ave., Emeryville, Calif., or American District Steam Co., North Tonawanda, N. Y.*

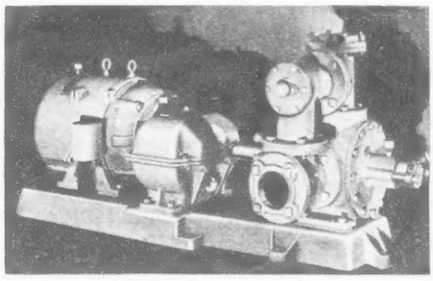
ROTARY PUMPS

OVER-ALL efficiency as high as 80 to 90%. Rotor and cylinder have rolling action. Unit is self-priming up to suction lift of 22 ft. and will produce on water, a dead-end vacuum of 29 in. at 30-in. barometer. Very quiet. Displacement mechanism consists of rotor and a free-rolling roller or abutment on top of rotor, roller provides positive seal and compensates for wear. Rotor, mounted eccentrically on shaft, has extended cut-off surface at high points which closes two ports at completion of each discharge, thus preventing back leak. Oilless bearings. Pressures up to 100 lb. on non-lubricant liquids at 275 to 300 r.p.m. All iron or all bronze.—*Anderson Rotary Pump Co., 120 Liberty St. New York, N. Y.*



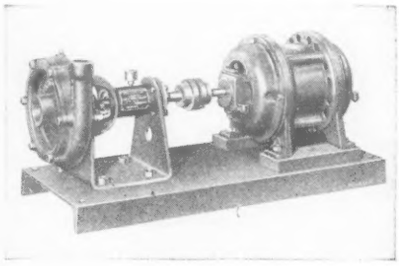
PUMPING UNITS

INTEGRATED rotary pumping units have pump on 3-point support base designed to take a high-speed NEMA-frame electric motor, connected to pump through enclosed gears running in oil. Bypass and strainer provided. Single units 35 to 700 g.p.m., twin units 50 to 100 g.p.m. Full-capacity bypass with no end thrust on working parts. Full-flow strainer. Bulletin IU300.—*Blackmer Pump Co., Grand Rapids, Mich.*



CENTRIFUGAL PUMP

PRESSED-STEEL frame and simple design. Direct motor drives or pulleys for belt drives. Motor sizes from 1/3 to 3 hp., delivering 10 to 130 g.p.m. with heads from 10 to 100 ft. Standard, all iron or all bronze fittings. Bulletin W-310-B5.—*Worthington Pump & Machinery Corp., Harrison, N. J.*



STEAM-JET EJECTORS

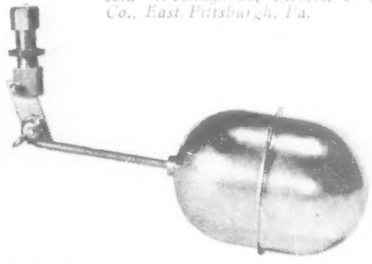
FOR vacuums from a few inches of mercury to within less than 1 mm. of perfect vacuum, single or multiple units. Can be used in condensers for power plants and in various process work. Bulletin W-295-B2.—*Worthington Pump & Machinery Corp., Harrison, N. J.*

VERTICAL TURBINE PUMP

SIMPLE, compact. For dewatering; capacities to 10,000 g.p.m. Fixed or portable unit. Total dynamic heads, 20, 30, 40, 50 and 60 ft., motor sizes 5 to 250 hp., 860 to 1750 r.p.m. Bulletin W-450-B25.—*Worthington Pump & Machinery Corp., Harrison, N. J.*

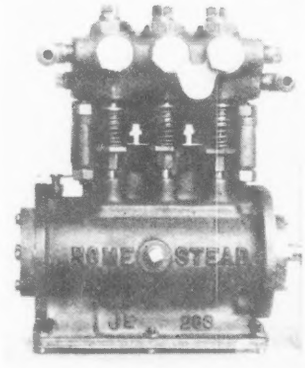
ELECTRONIC SPEED REGULATOR

ONE stage of amplification. Parallel tubes to avoid change in regulated speed in case of tube failure. Voltmeter on regulator, plugs into tube circuits. Three KU-628 grid-glow tubes, excited from 3-phase transformer, supply field current for generator exciter. Current flow through tubes controlled by grid voltage. Grid voltage subject to control by two RJ-571 amplifier tubes in parallel, controlled by voltage difference between pilot generator and 45-volt dry cell.—*Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa.*



AUTOMATIC WATER-TENDER

INCREASED clearance between body and relieving of upper corners of plunger; high-temperature graphited gasket; short, straight float rod; diaphragm formed solderless floats.—*Homestead Headquarters, 1893 E. 55th St., Cleveland, Ohio.*

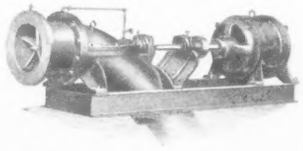


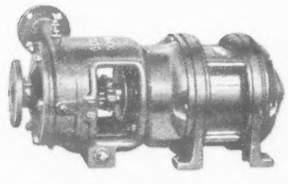
POSITIVE PUMP

MINIATURE triplex plunger reciprocating pump for small quantities of fluids at relatively high pressure. Capacity 15 to 120 gal. per hr., depending on speed. ¼-hp. motor for 60-gal. per hr. at 200 lb. pressure. Single-acting plunger pump has three cylinders ¾-in. by ⅝-in. with plunger attached to cross head guides driven by connecting rods from crank-shaft. Monel metal poppet-type inlet valves positively actuated through cam and tappet mechanism and outlet check valves with adjustable limited lift for high-speed operation. Pressure range from 0 to 500 lb.—*Homestead Valve Mfg. Co., Coraopolis, Pa.*

AXIAL-FLOW PUMP

CLASS A, for large volumes at low heads, is simple and can be direct-connected to a motor. Tube-shaped casing acts as part of water passage. Propeller similar to marine type. 12-, 16-, and 20-in. sizes.—*Pennsylvania Pump & Compressor Co., Easton, Pa.*





MOTOR-PUMPS

SMALL, light-weight Fig. 3620 motor-driven, centrifugal pumps for ordinary and corrosive liquids. 15 sizes

REGULATORS AND CONTROLLERS

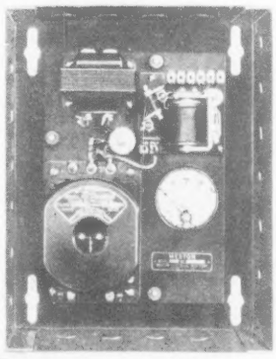
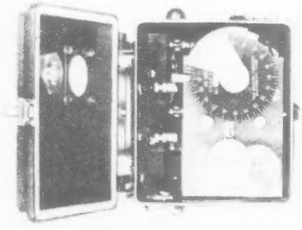


PHOTO-CELL CONTROL

SENSITIVITY and operating speed doubled. High-output photo-cell in protective mounting and complete relay in separate panel box. Light intensity of 100-ft. candles on cell operates relay with capacity of 500 watts output. Single-pole, double-throw relay has over-all speed response of 0.15 sec. Model 729.—*Weston Electrical Instrument Corp., Newark, N. J.*

MOTOR-OPERATED VALVE CONTROLLER

MULTI-POSITION controllers, Relatrol and Balancer produce corrective movement in valve or damper, in accordance with temperature change as measured by actuating instrument. Full line voltage in both relay and power motor. Cast-iron housing, 6¾x9¼ in. Balancer similar to Relatrol, except provided with automatic means of load compensation for heavily varying loads.—*Automatic Temperature Control Co., 34 East Logan St., Philadelphia, Pa.*

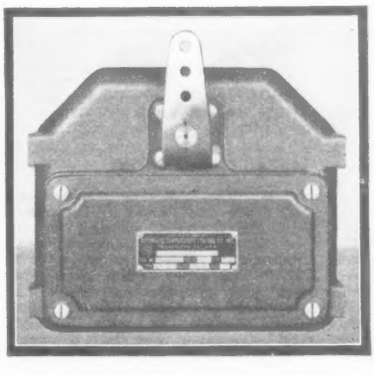


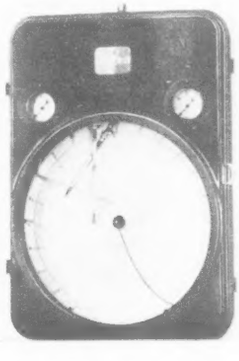
PROCESS-CYCLE CONTROLLER

MODEL 6088V is a variable-speed controller suitable for automatically controlling any cycle operation. Has one cam operating one or two patented, leakless, 3-way pilot valves as required. Cam readily adjustable. Bulletin 447.—*Bristol Co., Waterbury, Conn.*

PNEUMATIC RECORDER-CONTROLLER

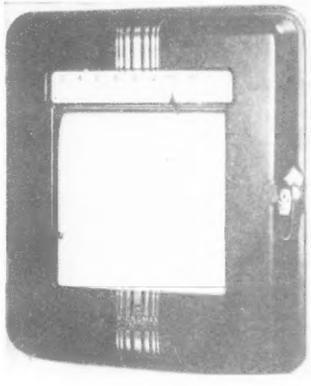
"AMPLISET" free-vane controller for temperature, flow, liquid level, pressure and humidity has adjustable sensitivity to fit process lag. Can be changed from direct- to reverse-acting. Bulletin No. 440.—*Bristol Co., Waterbury, Conn.*

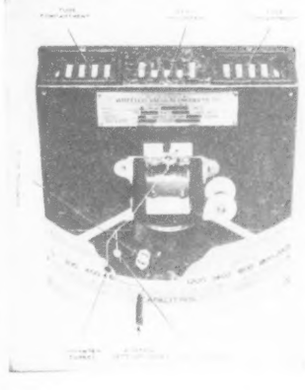




RECORDING CONTROLLER

"SILVER ANNIVERSARY" Micromax provides all combinations of indicating, recording, signalling and controlling. Pointer for instantaneous readings, while 10 in. of strip chart shows condition for past several hours. On controllers, second pointer shows control setting. Catalogue N-33A.—*Leeds & Northrup Co., 4934 Stenton Ave., Philadelphia, Pa.*





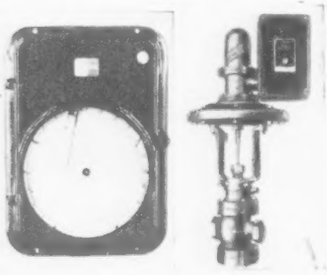
TEMPERATURE CONTROL

WHEELCO sytem has no electrical contacts. Tiny flag on pointer passes

through field of coil in oscillator circuit affecting grid excitation of electron tube. Change in grid excitation causes rise or fall in plate current, which actuates mercury-tube relay. Coil on movable table set manually. —*Thermo Control Devices, Inc., 114 Milwaukee Ave., Chicago, Ill.*

RECORDERS AND CONTROLLERS

MODEL D4OM low-range recording gages and controllers are equipped with inclosed bell-type measuring elements. For draft or pressure in minimum ranges of 0 to 0.2 in. of water and maximum ranges of 0 to 2.0 in. of water. Wall or flush panel mounting. Catalog—*Bristol Co., Waterbury, Conn.*

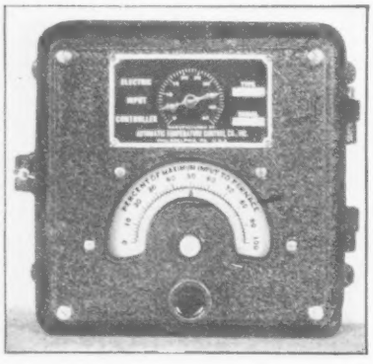


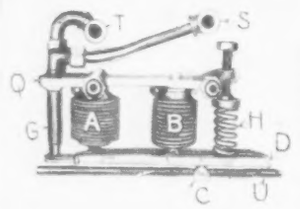
VERNIER VALVE CONROL

VALVACTOR enables throttling-type air-operated control instrument to make small gradual adjustments of control valve position, regardless of friction, hysteresis, or tight valve stem packing. Cast aluminum case, available in gas-tight construction. Attached to spring housing of "Stabilflo" valves or mounted on side of motor supports for needle valves and valves without Stabilflo type of motor.—*Foxboro Co., Foxboro, Mass.*

CONTROLLERS

FOR regulating current input to electrically-heated units; in four models: M to prevent temperature of constant load from rising above setting. MT same as M, but has time control. F for installations with slight lag, FL for greater lag in furnace response. Number may be used in series to control whole heating program. Aluminum case, 8¼x9¾x4¾ in.—*Automatic Temperature Control Co., Inc., 34 East Logan St., Philadelphia, Pa.*



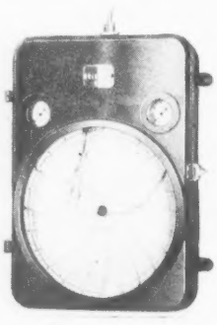


CONTROL UNIT

"ARCA" control is applicable to pressures, levels, speeds, temperatures, vacuums and flow. Has movable fulcrum for lever element which may be adjusted to suit conditions. Threaded shaft *U* turns in end bearings by means of a tool. Unit has two bellows, *A* and *B*, and flat spring *H*, latter adjustable to or from air nozzle *G*. Operated by compressed air. Air gage in elbow *T* indicates initial air pressure, needle valve *Q*, throttled to desirable low pressure and nozzle *G* provides desired pressure on diaphragm air motor. For ranges of 300 lb. and above, Bourdon tube replaces bellows *A*, with sensitivity of ½% plus or minus.—*Arca Regulators, Inc., 11 Orange St., Bloomfield, N. J.*

REMOTE VALVE CONTROL

MANUAL. Will change pressure on diaphragm motor of controlled valve as little as ¼ in. of water. Used with "Stabilflo" valve. Will operate through several hundred feet without pumping or vibrating.—*Foxboro Co., Foxboro, Mass.*



CONTROLLER

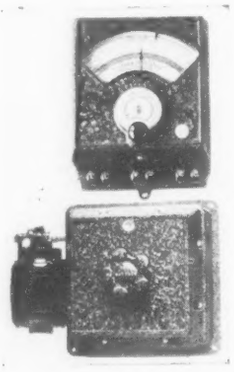
MODEL 90 for automatic temperature and pressure control where chart record is not necessary has wide-range sensitivity adjustment and can be changed from direct to reverse-acting. Wall and flush-panel mounting. Bulletin No. 444.—*Bristol Co., Waterbury, Conn.*

AUTOMATIC PRESSURE COMPENSATOR

ERRORS due to variation in static pressure while measuring flow of compressible fluids are compensated for by a spiral pressure tube connected to a lever. On square-root scales, pen position is varied with change in absolute pressure. On uniform scales, correction in proportional to square-root of change in pressure. — *Foxboro Co., Foxboro, Mass.*

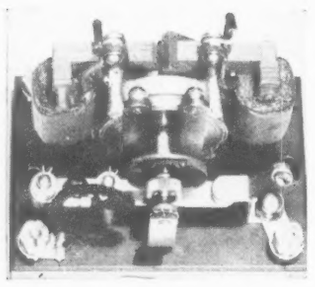
TEMPERATURE LIMIT CONTROL

WHEELCO Limitrol will indicate temperature within any range between 0 and 3,000 deg. When temperature reaches limit set on index, relay operates and rings bell, lights signal, etc. May be used with motor or manually operated switch to connect up to 39 thermocouples at 10-sec. intervals.—*Thermo Control Devices, Inc., 1114 Milwaukee Ave., Chicago, Ill.*



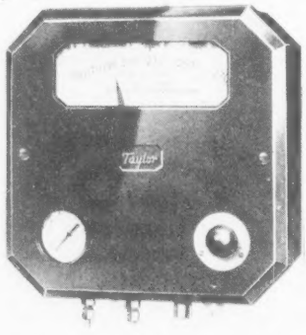
CONTROLLERS

MASTER free-vane controllers for temperature, time temperature, flow, liquid level, pressure, time-pressure and humidity are offered primarily for application where a greatly reduced sensitivity is required and load conditions fluctuate over a wide range. Pneumatic type. — *Bristol Co., Waterbury, Conn.*



TIMING DEVICES

SYNCHRONOUS-MOTOR drives cams through chain of gears in immediately-recycling timing device. Other types.—*Struthers. Dunn, Inc., 139 N. Juniper St., Philadelphia, Pa.*



INDICATING CONTROLLER

"TALSCOPE" air-operated controller with high-range or full-range sensitivity for short and long-time lags, adjustable control point and reversible action. Control ranges from—100 to 1,200 deg. F. and 0 to 2,000 lb. abs. Temperature controller with mercury-, vapor- or gas-actuated tube systems. Catalog 86 R.—*Taylor Instrument Cos., Rochester, N. Y.*

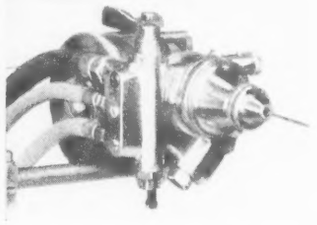
WELDING EQUIPMENT

DUAL ARC-CONTROL WELDER

"SHIELD-ARC SAE" welders have new arc control which makes possible adjustment of both arc heat and penetration in a continuous sequence of fine increments. Polarity reversing switch, no-voltage motor protection, etc. Shorter wheel base. Types and ratings incline a.c. motor-drive, 200, 300, 400 and 600 amp.; d.c. motor-driven, 300, 400, and 600 amp.; generator for belt or couple service, 200, 300, 400 and 600 amp.; engine-driven, 200, 300 and 400 amp.—*Lincoln Electric Co., Cleveland, Ohio.*

METAL-SPRAY GUN

MOGUL Model A for irons, Monel and steels and Model B for aluminum nickel, silver, brasses, bronzes and copper, steps up spraying speeds atomization. Difference is in inter-200 to 300% while maintaining fine changeable gearing. Single-valve control. Nozzle redesigned to get flames closer to wire by using hardened steel wire-guide tube, and pressures stepped up also if desired by operator. Designed for mounting in lathe; can be equipped with handle for portable use. Either wire or rod can be used.—*Metallizing Co. of America, Inc., 1218 Long Beach Ave., Los Angeles, Calif.*



DUPLEX RUBBER HOSE

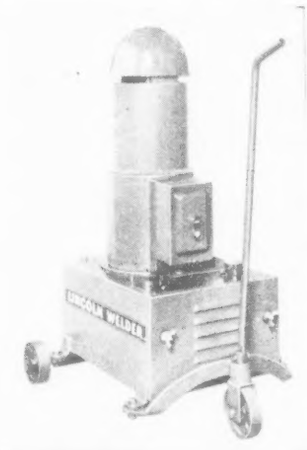
"SUPERO SIAMEEZ" twin rubber hose for gas welding and cutting, etc., has connecting web molded between and cord-wound reinforcement between first and second braid. ¼-in. size has bursting strength of 2,000 lb. per sq. in. Hoses may be same or different colors.—*Electric Hose & Rubber Co., Wilmington, Del.*

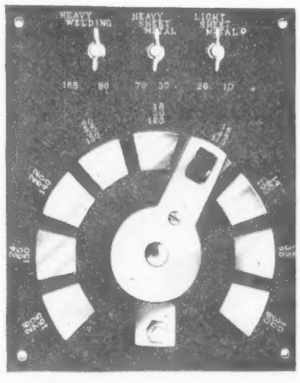
75-AMP. WELDER

STABLE high-speed arc is produced by combining magnetic bridge as part of main pole assembly and spreading pole shoes well around holes in which stabilizer coils are embedded. 5-hp., fan-cooled, squirrel-cage motor on top operated by pushbuttons and equipped with no-voltage release and overload protection. Connections for 110 to 550 volts or for special voltages of 2- and 3-phase, 60 and 50 cycles.—*Harnischfeger Corp., Milwaukee, Wis.*

ARC WELDER

SA-150 motor-driven, single-operator type has rated current range of 45 to 200 amp., and can be used with either bare or shielded electrodes. Dual control of voltage and current. Powered by 7½-hp. a.c. motor for 60-cycle power circuits of 220 or 440 volts, 3- or 2-phase. Portable or stationary models.—*Lincoln Electric Co., Cleveland, Ohio.*





SWITCH FOR WELDER

DIAL control has amperages marked on switchboard. Setting dial at top gives operator absolute control of amperage. Dial switch cannot "short" electrical circuit between contacts.—*Miller Electric Mfg. Co., Inc., Appleton, Wis.*

ARC WELDER

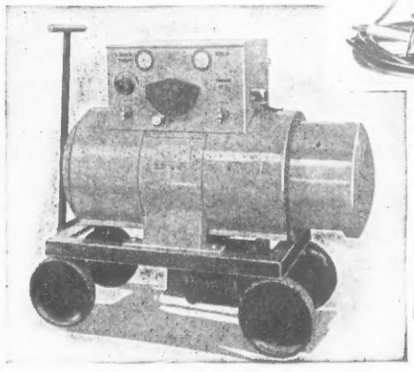
HANSEN "Smootharc" has single current control, self-excitation and internal stabilization. Two styles, vertically mounted in 75, 100, and 150-amp. capacities, horizontally mounted in 200, 300, 400, and 600-amp. Single control panel built into housing. Rolled steel, arc-welded. All steel parts annealed to improve magnetic field for generator fluxes.—*Harnischfeger Corp., Milwaukee, Wis.*

JOINT-STRESS RELIEVER

PORTABLE low-frequency heating coil and protective insulating shield hinged so can be clamped around pipe weld. Tap-change transformer with auxiliary equipment for controlling electric energy to heating coil and controlling pyrometer mounted on portable hand truck. Primary cable connected to any 60-cycle power supply of about 100 kva. capacity. Rate of cooling can also be controlled if desired.—*Detroit Electric Furnace Co., 825 W. Elizabeth St., Detroit, Mich.*

WELDER

NOEL "Speedarc" has unity power factor at full load and leading power factor up to 40% at no load for supplying power factor correction. Claimed to have 10 to 13% higher over-all efficiency. High speed, lower operating cost, constant settings, dual control, etc. 125 to 400 amp., with truck or stationary mounting. Control centralized on top. Circular 911.—*Ideal Electrical & Mfg. Co., Mansfield, Ohio.*



ARC WELDER

MODEL W-150 using bare or coated electrodes from 3/32 in. to 3/16 in. Single current control by shifting brush holders for current settings over entire range. Mounted on 2-wheel highway trailer, small 4-wheel industrial truck or on skids. Motor-driven model, stationary or portable, with V-belt drive. Gasoline-engine driven units direct connected at 2,200 r.p.m., mounted on steel base.—*Harnischfeger Corp., Milwaukee, Wis.*

WELDING ELECTRODES

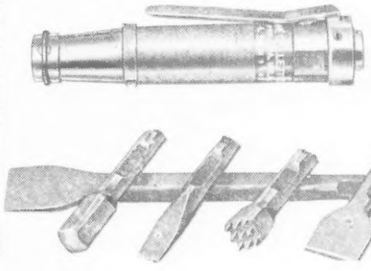
"SMOOTHARC" coated rods for d.c. welding include five types with both high and low rates of fluidity. Tensile strength of welds from 55,000 to 75,000 lb. per sq. in., with rods ranging from 3/32 to 3/8 in. Bulletin No. R-1.—*Harnischfeger Corp., Milwaukee, Wis.*

LOW-TEMPERATURE BRAZING ALLOY

ADDED "Sil-Fos" strip thickness, 0.005 in. in widths of ¼ in. or more. To wire-form "Easy-Flo" has been added 3/64-in. diam., and four new gages of strip: 0.020 in., 0.010, 0.005 and 0.003 in., all ¼ in. or more in width. Additional forms and sizes, including washers, circles, rings and filed or powdered forms.—*Handy & Harman, 82 Fulton St., New York, N. Y.*

A.C. WELDER

"JUNIOR" in 4 models from 90 to 300 amp. has wood cabinet, etc., is lighter and cheaper than standard model. Two models have only 10 amperage control points, others 16, while standard models have 27 and 36. Special transformer type without reactance control, static high-frequency arc or sheet-metal attachment. Same insulation thickness and temperature rise as standard models. Rotating knife-switch amperage control. Can be used on grounded systems and for water-pipe thawing.—*Giant Grip Mfg. Co., Oshkosh, Wis.*



WELD-FLUX SCALER

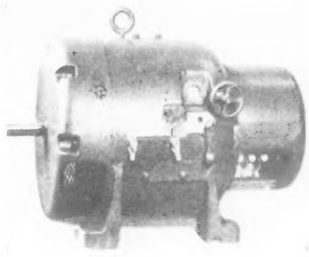
UNIT chips, peens, and removes flux from arc-welded joints. Safety retainer-shank chisels, either round or quarter octagon. Two sizes, RS-3L, 7,000 strokes per min., weighing 2 lb. and using 5 c.f.m. of air; RS-4L, 7,250 strokes per min., weighing 4 lb., and using 6 c.f.m. of air. Bulletin 2235-A.—*Dallett Co., 165–189 Clearfield St., Philadelphia, Pa.*

BRAZING ALLOY

PHOS-COPPER alloy is now annealed and pickled to avoid carbonacious deposit on surface which might interfere with production of leakproof joint. Relatively low melting point, high tension strength and excellent penetration. Melting point 707 deg. C.—*Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa.*

WELDING TORCH

LIGHT-WEIGHT welding torch weighing only 17½ ounces with tip. Fluted wheel handles have spring tension to hold adjustments. Standard and super types.—*Modern Engrg. Co., 3411 Pine St., St Louis, Mo.*



WELDING GENERATOR

CROSS-FIELD principle eliminates rheostat, resistors, meter, reactor and exciter. Mechanical control of welding current through control of armature reaction fluxes. Switch changes polarity. 200-, 300- and 400-amp. units give currents from 60 to 500 amps. — *Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa.*

ARC-WELDING ELECTRODE

"STAINWELD B" electrode for 25-12 stainless steels, provides weld metal of same characteristics as steel containing 25% chromium and 12% nickel. Heavily coated, utilizing shielded-arc principle. Weld metal resists stress of 95,000 lb. per sq. in. 5/32-in. and 3/16-in. sizes, in 11-in. lengths.—*Lincoln Electric Co., Cleveland, Ohio.*

A. C. WELDERS

LINE of low-priced welders to supplement "Wonder Arc" type.—*Miller Electric Mfg. Co., Appleton, Wis.*

A.C. WELDER

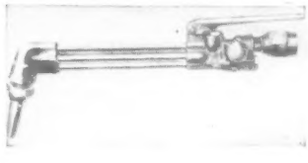
"WONDER ARC" is portable, transformer type with high p.f., having reactance control, static high-frequency arc and sheet-metal attachment. Capacities 125 to 600 amp. standard voltage 220, 60 cycles, single-phase. Not auto-transformer type; rotating knife switch amperage control.—*Miller Electric Mfg. Co., Appleton, Wis.*

CHROME-STEEL ELECTRODE

"CHROMEWELD 4–6" welds 4–6% chromium steels for resistance to crude-oil corrosion at high temperatures and pressures. Contains molybdenum; can be soft-annealed to physical properties similar to those of mild carbon steel. Three sizes, ⅛, 5/32 and 3/16 in.—*Lincoln Electric Co., Cleveland, Ohio*

OXY-ACETYLENE CUTTING ATTACHMENT

OXWELD Type CW-22 for Types 17 or 22 handles is suitable for all but heaviest work. Cutting valve centralized under cutting lever has removable seat. Mixed gas passage of three Ambrac tubes. Forged-bronze body.—*Linde Air Products Co., 30 East 42nd St., New York, N. Y.*



WELDING ELECTRODE FOR BRONZE, BRASS AND COPPER

"Aerisweld" phosphor-bronze, arc-welding electrode. Coating produces gas which shields molten metal from atmosphere and assists flow in arc. Uses positive welding current. 5/32-in. and 3/16-in., 14-in. lengths, in standard containers of 5 lb. net.—*Lincoln Electric Co., Cleveland, Ohio.*

OXY-ACETYLENE REGULATORS

Oxweld Type R 64 suitable for welding and cutting up to a required oxygen pressure of 75 lb. per sq. in. Type R-65 designed for cutting with oxygen pressures up to 200 lb. per sq. in., but can also be used for welding at low gas pressures if necessary. All have stem-operated valves which close with instead of against incoming pressure, sensitive rubber diaphragm, self-contained first-stage valves, pressure-forged bodies and caps.—*Linde Air Products Co., 30 East 42nd St., New York, N. Y.*

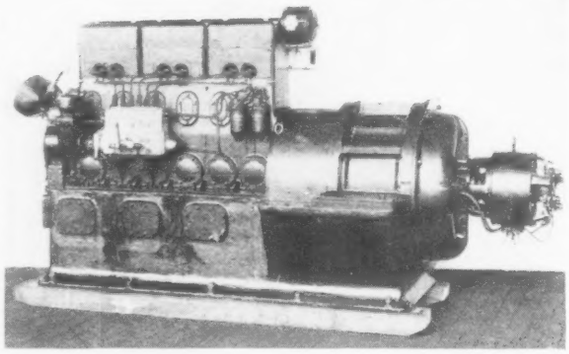
2-CYCLE HEAVY-DUTY DIESEL

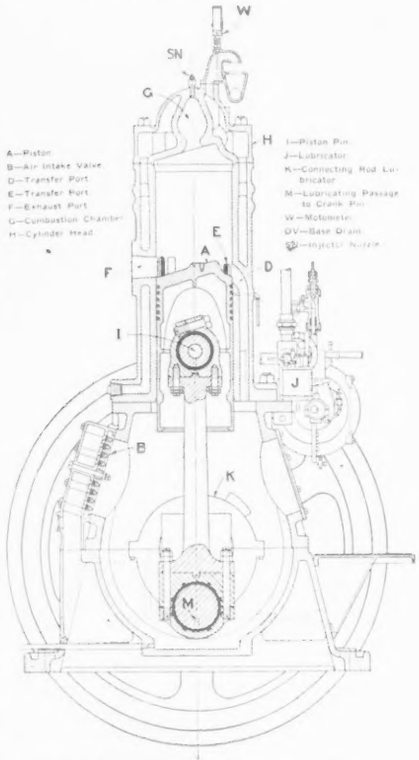
Type KD, cold-starting, mechanical-injection engine can rotate in either direction. 257 r.p.m. to suit direct-connected generators. Two flywheels suitable for driving belts if desired. Readily accessible fuel pumps which can be stopped individually while unit is in operation. Centrifugal enclosed-type governor in crankcase which shortens and lengthens fuel-injection pump stroke proportional to load. Piston speed 771 f.p.m. 1 to 6 cyl. with ratings of 50 to 360 hp.—*Anderson Engine & Foundry Co., Anderson, Ind.*

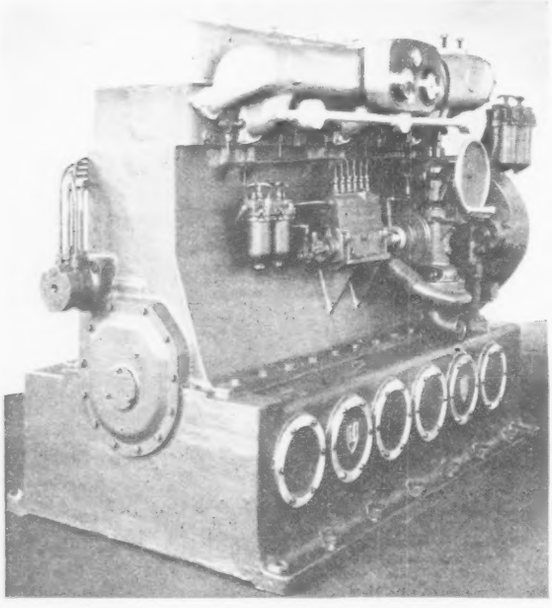
STEAM, OIL AND GAS PRIME MOVERS AND AUXILIARIES

HIGH-SPEED DIESEL *(Below)*

Model VI, 4-cycle, solid-injection for 100 to 200 hp. at 900 r.p.m. for stationary service and to 240 hp. at 1,200 r.p.m. for light-duty service. 4, 6 or 8 7x8-in. cylinders. C.I. removable liners and aluminum-alloy pistons. Totally enclosed. Cam and lay shafts gear driven. Bosch fuel pumps and valves, latter multi-orifice spraying into a pear-shaped combustion chamber. Pressure lubrication. Standard accessories include governor, centrifugal water pump, fuel-service and lubricating-oil pumps, fuel filter, and duplex lubricating-oil filter. Bulletin 79.—*De La Vergne Engine Co., Paschall P. O., Philadelphia, Pa.*





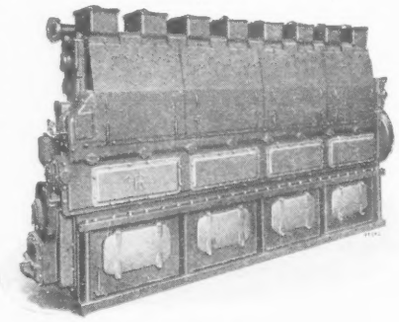


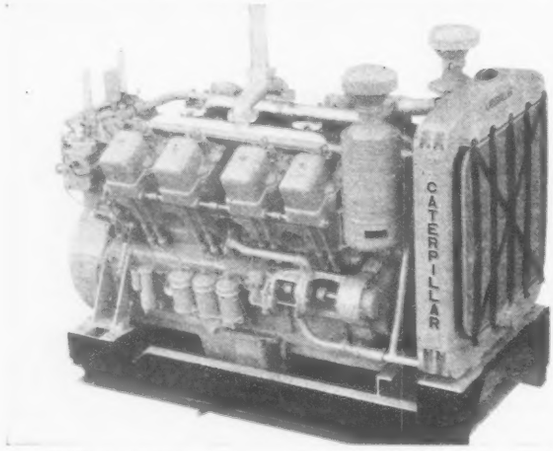
DIESEL-ELECTRIC SETS

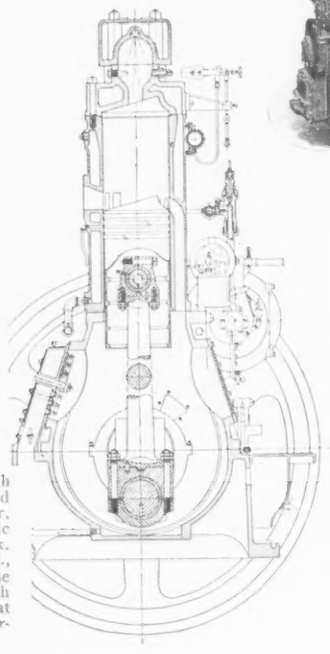
Model GA, 2, 4 or 6-cyl., 4½x5¼-in., 4-cycle, cold-starting solid-injection diesel sets deliver 10 to 50 kw. at 1,200 r.p.m. Cylinder and crankcase enbloc. Wet-type interchangeable alloy C.I. liners. Nickel-alloy iron heads cast in pairs, and overhead valves. Self-contained fuel pump with individual barrels and plungers for each cylinder. Pintle-type nozzle. Vertical centrifugal governor. Pressure lubrication. Electric starting. Bulletin 535.—*Otto Engine Works, Holmesburg, Philadelphia, Pa.*

2-CYCLE OIL ENGINE

Type M 2-cycle oil engine in three cylinder sizes, 10x14 at 327 r.p.m., 12½x18 at 277 r.p.m., and 14x18 at 277 r.p.m., giving rated horsepowers varying from 30 to 360, with one to four cylinders for the two smaller sizes and one to six for the larger. Forged connecting rods, automatic governor and injection pump in one unit, with separate pumps for each cylinder actuated by individual tapered cams and rollers. All cylinders may be primed at any position. Separate wire gaskets. Bulletin 336.—*Anderson Engine & Foundry Co., Anderson, Ind.*







V-8, 160-HP. DIESEL

D17000, to be combined with an 80-kw. generator or as a power unit is a 4-cycle, valve-in-head, solid injection diesel. Integral radiator and fan. 5¾x8 in., governed to 850 r.p.m. Cylinders in two groups of four, at 60 deg. Liners heat-treated chrome-nickel alloy cast iron. Cylinder blocks cast in pairs. Individual fuel pumps in one line at center of V, with even-length fuel lines. Fuel- and lubricating-oil filters, air cleaner, manifolding, cooling and thermostatic control individual for each bank. Force-feed lubrication, 28-hp., 2-cyl., horizontal, gasoline starting engine mounted at rear over flywheel, with circulating system tied in with that of diesel to speed starting.—*Caterpillar Tractor Co., Peoria, Ill.*

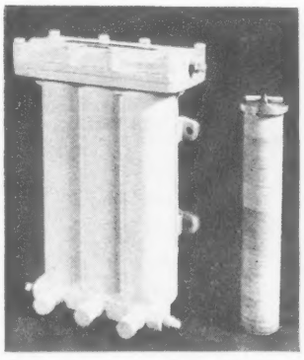
DIESEL ENGINE

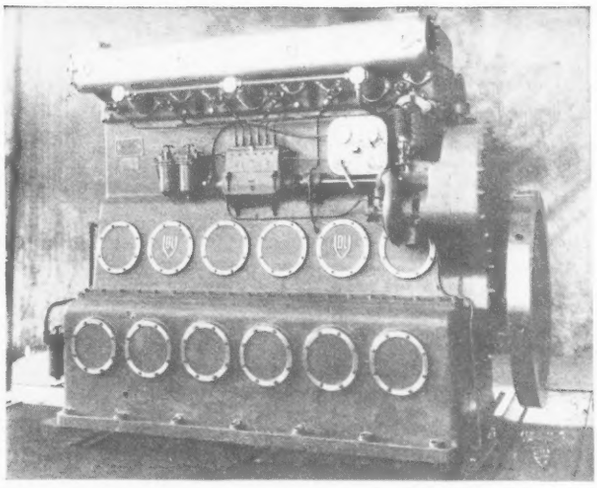
Type S, vertical, 4-cycle, single-acting, solid-injection diesel is a medium-speed heavy-duty, continuous-service unit. 3, 4, 5, 6 or 8 cylinders for ratings of 150 to 460 hp. Full enclosure, force-feed lubrication. 514 to 600 r.p.m.—*Ingersoll-Rand Co., 11 Broadway, New York, N. Y.*

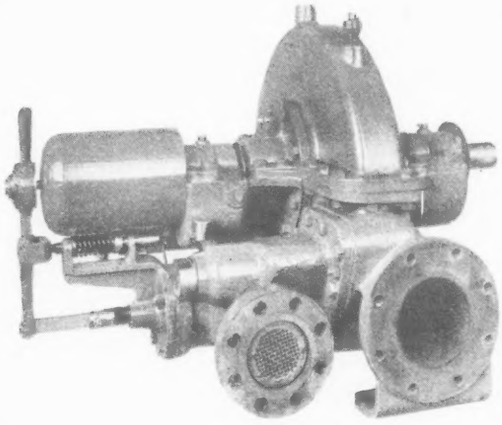
DIESEL FUEL FILTER

Type F-3 streamline filter uses filter element (shown at right of unit) composed of hundreds of special paper washers stacked on a central tube under compression. Quarter-millionth inch spaces between washers. Operation continuous until dirt on surface retards capacity, then filter is flushed off by forcing a few ounces of oil back through between disks. Filter usually made up in nest of three packs, so that one may be cut out and flushed clean while others stay in service. Alternate cleaning arrangement when heavy fuels are

filtered replaces back-pressure flow of filtered oil with a small pump and lighter, faster-flushing oil. Unit can be connected into present injector lines. 6⅜ in. wide x 11¾ in. high by 2¼ in. thick.—*Skinner Purifiers, Inc., 2231 Dalzell St., Detroit, Mich.*

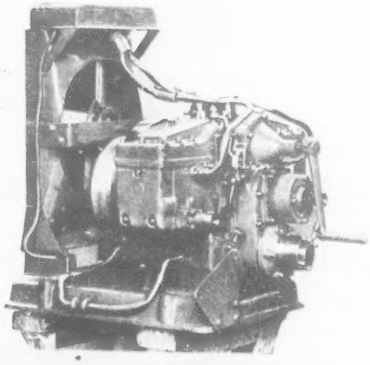


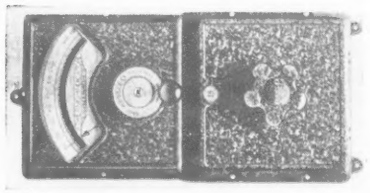




STEAM TURBINES

TYPE C, for driving general-purpose auxiliaries, are impulse type with one pressure and two velocity stages. Capacities 5 to 50 hp. at 1,000 to 5,000 r.p.m. Pressures to 650 lb. gage and total temperatures to 750 deg. F. May be operated either condensing or non-condensing; rotation in either direction. Clean exhaust suitable for processes.—*Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa.*





DIESEL TEMPERATURE INDICATOR

USING Wheelco system, this Thermo-Indicator, high-resistance indicating pyrometer will show temperature at up to 39 points. Motor or manually operated switch connects to various thermocouples at 10-sec. intervals. Seven ranges, 0 to 400 to 0 to 3,000 deg.—*Thermo Control Devices, Inc., Chicago, Ill.*

MEDIUM-SPEED DIESEL

(Left)

MODEL VE solid-injection unit, 4, 6 or 8 cyl., b.hp. from 120 (4 cyl. at 400 r.p.m.) to 400 (8 cyl. at 720). All working parts accessible and renewable. Total enclosure. Pressure lubrication through drilled passages. Removable C.I. liners. Up to 600 r.p.m., pistons are C.I., above that aluminum alloy. Cylinder heads cast integral for each two cylinders. Bosch fuel pumps and spray valves individual for each cylinder. Multi-orifice spray valve. Pear-shaped combustion chamber. Accessories include flyball governor, attached centrifugal water pump and fuel-service pump, lubricating oil pump, fuel-oil strainers, duplex lubricating oil strainers. Bulletin 87.—*De La Vergne Engine Co., Paschall P. O., Philadelphia, Pa.*

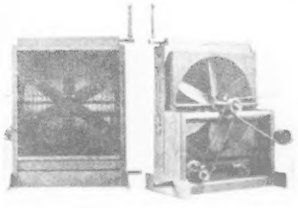
HORIZONTAL-OPPOSED DIESEL ENGINE

(Left)

TWO-CYL. diesel weighs 280 lb., including 60-lb. flywheel, and develops from 15 to 18 b.hp. at 500 to 3,500 r.p.m. 30 in. wide x 18 long and 18½ in. high.—*Corle Diesel Engine Corp., Burbank, Calif., and Detroit, Mich.*

JACKET-WATER COOLING SYSTEM

Two models in 8 sizes, designed to cool gasoline or diesel engines from 29 to 132 hp. Self-contained, including cooling coil, fan, bearings, drive sheaves, pump. Bulletin.—*Young Radiator Co., Racine, Wis.*



EXHAUST LINES

By E. J. Tangerman

"I divide the world into three classes . . . the few who make things happen, the many who watch things happen, and the overwhelming majority who have no notion of what happens." —Dr. Nicholas Murray Butler.

A turbine manufacturer sent a repair man to a small southern town to overhaul a turbine. After the work was completed, one townsman strolled up to the repair man and said, "You certainly fixed that machine." Naturally, the service man asked: "How's that?" "Well," replied the native, "we have one of those new-fangled clocks, and before you came that clock lost just five minutes up to the time the 12 o'clock whistle blew. Now it is right on time with the whistle."

We consume half of the world's coffee, tin and rubber, three-fourths of the world's silk, one-third of the coal, and two-thirds of all the crude oil. We also use most of the chocolate, 60% of it in candy bars. But we harvest over half the world's food from only 6% of the acreage.

An increase in production of electrical energy in France is reported for the first seven months of 1936 as compared with the corresponding period of 1935. In 1936, 6,516,278,000 kw.hr. were produced as compared with 6,226,326,000 kw.hr. in the same period of 1935. This does not include energy produced by central stations which produced about 4% of the total output, nor from mines, smelters, or other industrial power plants. Hydro production increased by 465,000-kw. hr., while steam production dropped by 175,000.

Some people prefer to learn the tricks of the trade rather than the trade itself.

The spider eats 25 times its own weight every day. To equal this ration, the average man would have to eat some 1½ tons of food.

A Governor was being shown through one of the state institutions by its superintendent, who, by the way, was a doctor. "How much does the electricity cost to light this place?" the Governor asked as he entered one building. "Not a damn cent," the doctor replied. "You know, we use our steam for heating and get the electricity as a byproduct." When the Governor was leaving, he asked: "By the way, doctor, how much does it cost to heat this place?" "It doesn't cost one damn cent," was the answer. "Governor, we make our electricity and get our heating as a byproduct!"

The humming noise of high-tension lines that cross pastures becomes so irritating to cows that they cease to give milk.

The first mechanical ice machine in this country was imported in 1859.

SANTA CLAUS . . .

Christmas Eve, and behind closed doors, Dad and Mom decorate the Christmas tree and wrap the presents. And perhaps Dad puts on a fancy red suit, a long white beard and a couple of pillows, and tries to squeeze down the chimney or through a convenient window with a bag full of presents. But one year or another, his beard slips or his voice shifts from falsetto to natural and the kids learn that age-old truth—"There Ain't No Santa Claus."

Most of us, at one time or another, believed in a Santa Claus, and most of us would still like to believe in him. There's an agreeable feeling about expecting things from a jovial fellow, in spite of a submerged worry that he may have found out about our shortcomings and is bringing us only switches.

A grown-up, however, must face reality—sooner or later, he must realize that sitting and wishing for something won't get it. In your plant and mine, we may wish for a cleaner plant, better equipment, or lower costs, but wishing won't get 'em for us. All that comes down a power-plant chimney, even at Christmas time, is soot.

But be your own Santa Claus. You can get the things you want if you can prove that you need them and that they will save their cost. Even a clean plant pays—in better morale, reduction of accidents and danger, and in showing up potential trouble normally hidden under a coat of dirt. Clean operation promotes efficiency, which means lower costs. And the man who runs a shipshape plant usually has a much easier job of convincing the powers-that-be that the new equipment he has in mind will pay out.

Beyond all that, you can still be your own Santa Claus—at least to the power-plant crew. Sure they grouse at you and some of them may be after your job—it's a good thing they are or you'd have no incentive for going ahead. Still, you're the boss, and what you do directly affects everything they do.

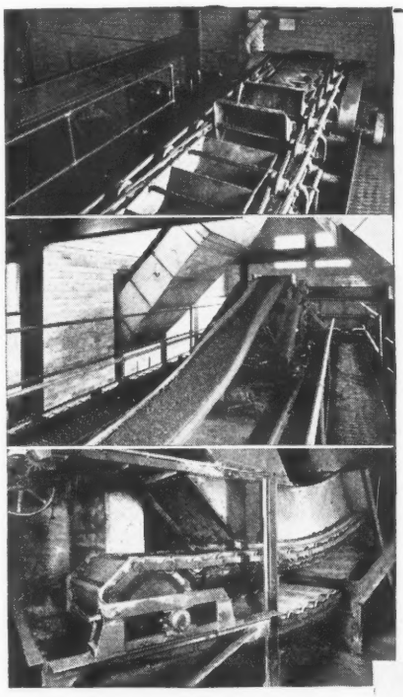
You may not be able to give them monetary rewards for being "good boys," but you can recognize efficiency by advancement, reward ambition with promotion, and repay cooperation with a sincere "Thank You!" Every man appreciates praise and thanks; you have the power to give at least *that* at Christmas.

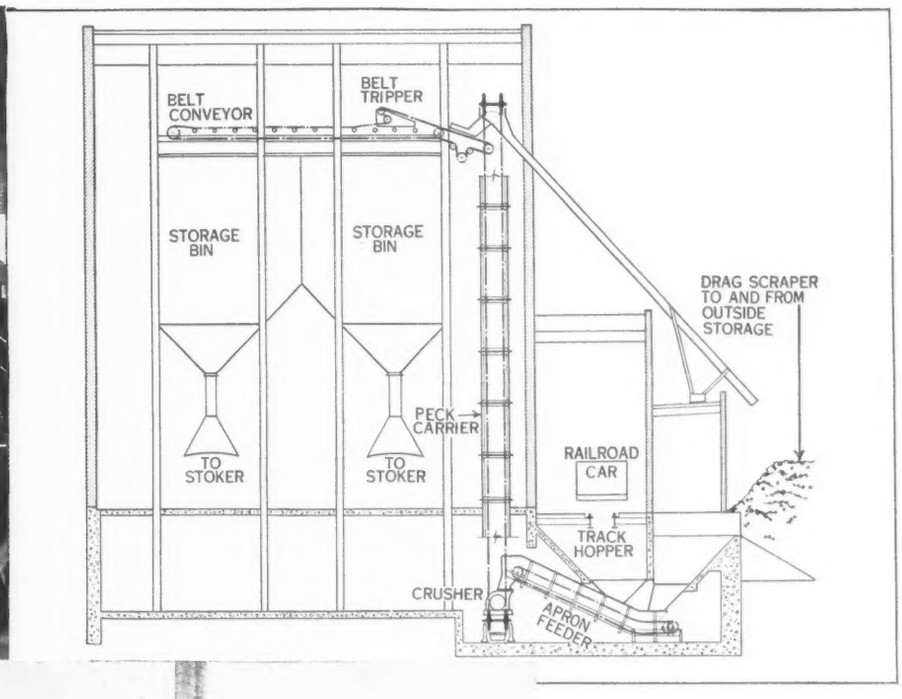
And a Merry Christmas to you!

George Edwards

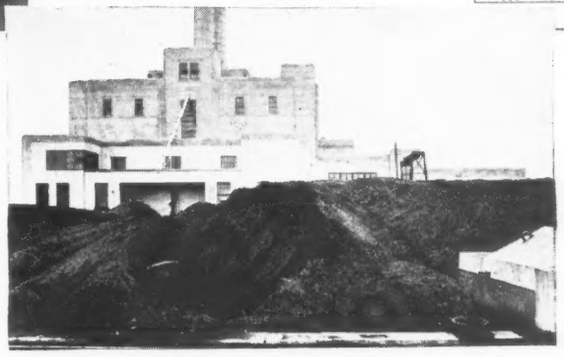
GEORGE EDWARDS,
Engineer

How coal is Handled at *Detroit's Springwells Station*





Coal is unloaded from R. R. cars at receiving station to apron feeder, to crusher, to pivoted bucket Peck carrier, to belt conveyor, to overhead bunkers. If desired, the carrier can be arranged to deliver to a spout, discharging to storage yard outside building. A drag scraper is used for distributing the coal over the storage area and for reclaiming. The entire system is automatically controlled from one board in the switch house.



● Of modern design and high efficiency is this pumping and filtration plant of the water department of the City of Detroit. It receives water through a tunnel twelve miles long and distributes it to the city's great northwest section.

It is completely equipped with Link-Belt coal conveyors as illustrated and described above. These sturdy, economically-operated units assure maximum dependability and efficiency so necessary to the continuous, low-cost operation of this plant.

Hundreds of plants, both large and small, use Link-Belt coal and ashes handling equipment for no other reason than that it is best for the purpose. Link-Belt Company, Philadelphia, Chicago, Indianapolis, San Francisco, Toronto. 5894

THE SYMBOL OF QUALITY · LINK-BELT · LB

LINK-BELT

Builders of

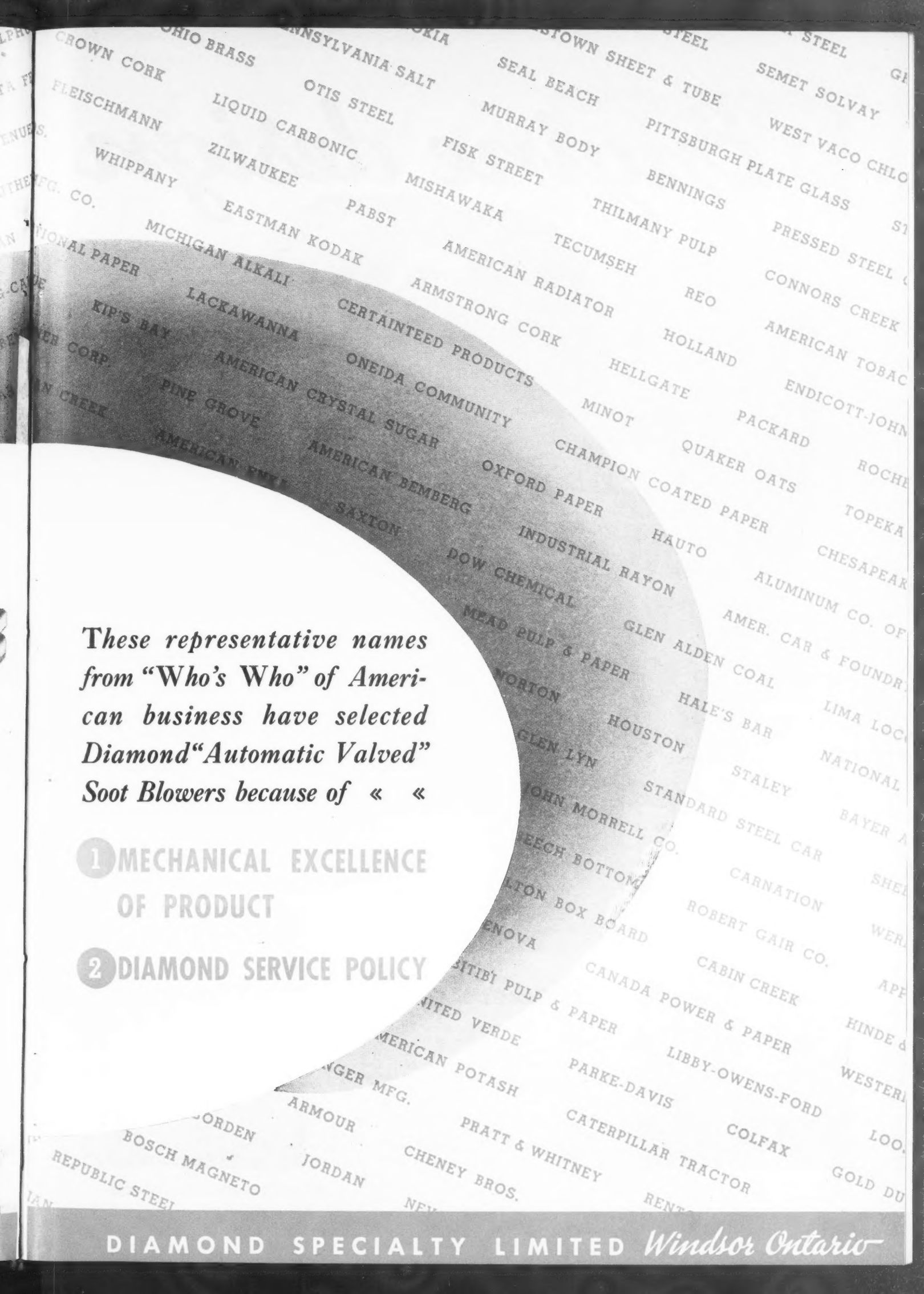
COAL AND ASHES HANDLING EQUIPMENT

IN ALL MODERN STEAM PLANTS ARE DIAMOND

"Automatic Valved"

which require only one operation to open and close the valve in head and simultaneously rotate the element « « «

DIAMOND POWER SPECIALTY CORPORATION *Detroit*


These representative names from "Who's Who" of American business have selected Diamond "Automatic Valved" Soot Blowers because of « «
1 MECHANICAL EXCELLENCE OF PRODUCT
2 DIAMOND SERVICE POLICY
OHIO BRASS
CROWN CORK
FLEISCHMANN
WHIPPANY
LIQUID CARBONIC
ZILWAUKEE
EASTMAN KODAK
PABST
OTIS STEEL
PENNSYLVANIA SALT
MICHIGAN ALKALI
AMERICAN RADIATOR
ARMSTRONG CORK
SEAL BEACH
MURRAY BODY
FISK STREET
MISHAWAKA
TECUMSEH
THILMANY PULP
BENNINGS
REO
HOLLAND
HELLGATE
MINOT
CHAMPION COATED PAPER
HAUTO
QUAKER OATS
PACKARD
ENDICOTT-JOHN
CONNORS CREEK
AMERICAN TOBAC
ROCHE
TOPEKA
CHESAPEAK
ALUMINUM CO. OF
AMER. CAR & FOUNDR
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SEMET SOLVAY
PITTSBURGH PLATE GLASS
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KIP'S BAY
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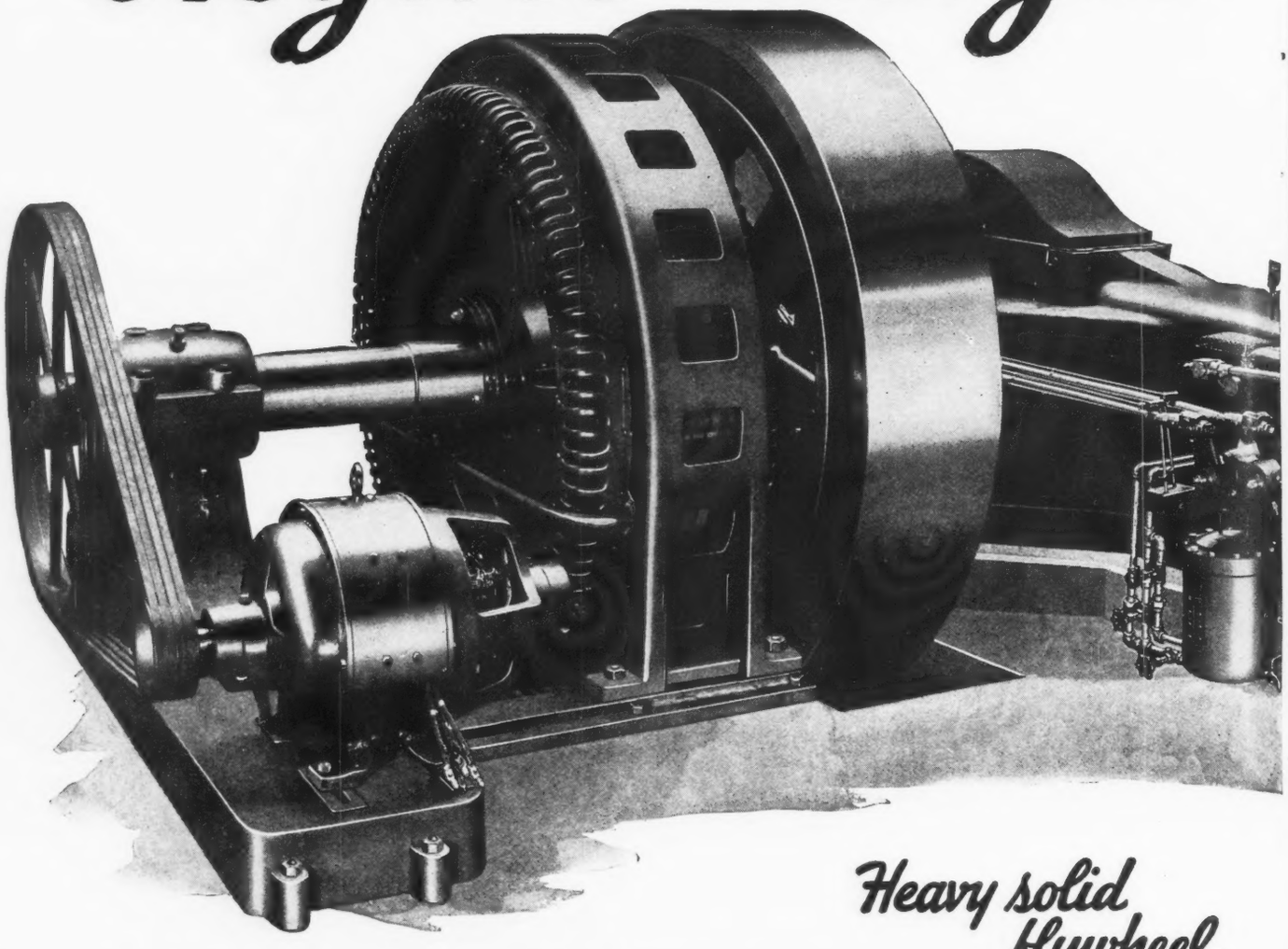
CERTAINTEED PRODUCTS
ONEIDA COMMUNITY
AMERICAN CRYSTAL SUGAR
PINE GROVE
AMERICAN BEMBERG
SAXTON
OXFORD PAPER
INDUSTRIAL RAYON
DOW CHEMICAL
MEAD PULP & PAPER
NORTON
HOUSTON
GLEN LYN
OHN MORRELL CO.
EECH BOTTOM
LTON BOX BOARD
ENOVA
BITIBI PULP & PAPER
NITED VERDE
MERICAN POTASH
NGER MFG.
ARMOUR
PRATT & WHITNEY
CHENEY BROS.
ORDEN
BOSCH MAGNETO
JORDAN
REPUBLIC STEEL
GLEN ALDEN COAL
HALE'S BAR
STALEY
STANDARD STEEL CAR
CARNATION
ROBERT GAIR CO.
CABIN CREEK
CANADA POWER & PAPER
LIBBY-OWENS-FORD
PARKE-DAVIS
CATERPILLAR TRACTOR
COLFAX
RENT
NEV
IAN
DIAMOND SPECIALTY LIMITED Windsor Ontario

Engine design

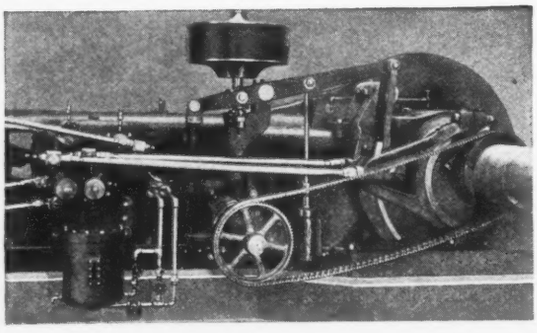


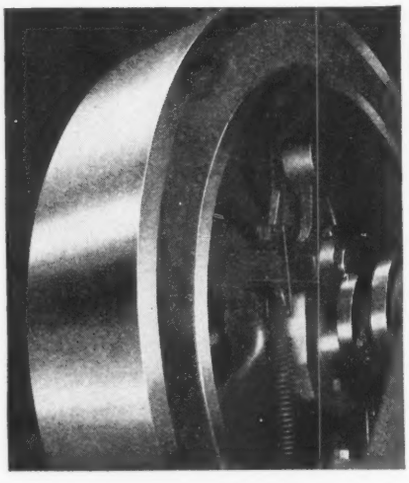
Heavy solid flywheel

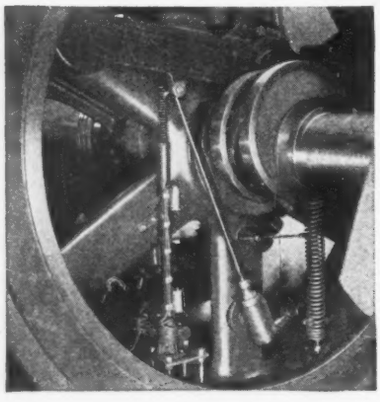
Solid wheels have 40 to 75 per cent greater factor of safety than split wheels. Our wheels are designed to suit the service by the co-operation of Elliott mechanical and electrical engineers. Generally, Elliott wheels are heavy and massive, making for smooth operation.

Speed changer

A reversible motor with built-in speed reducer is mounted on an adjustable baseplate. The thrust of the auxiliary spring is taken by a tapered roller bearing. Improved limit switches stop the motor at the two extremes of travel. Result — simplicity, durability, sure and effective operation.



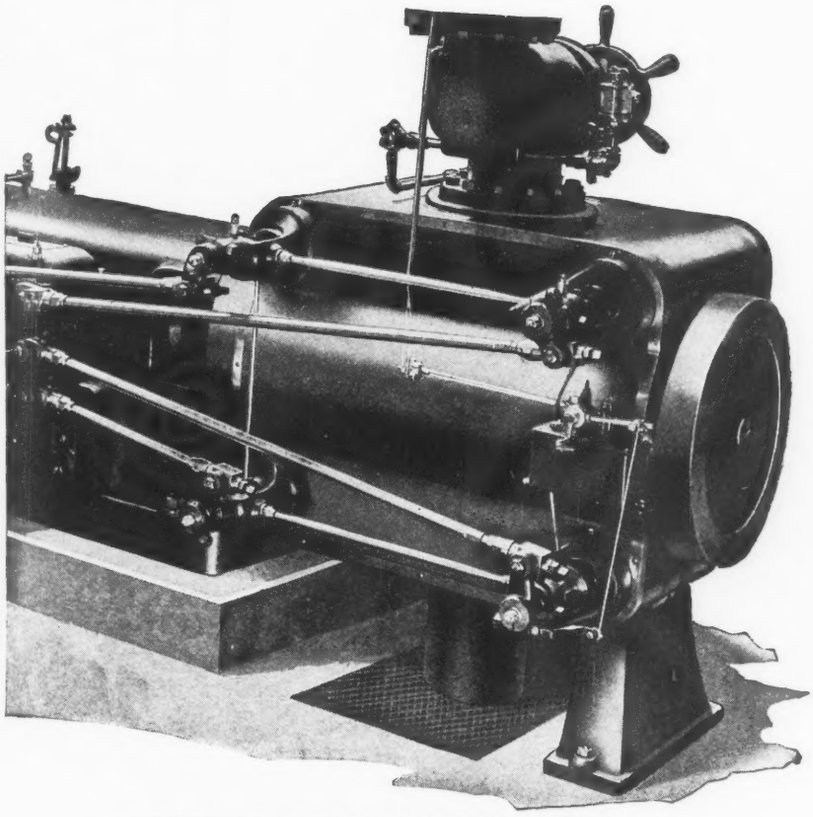


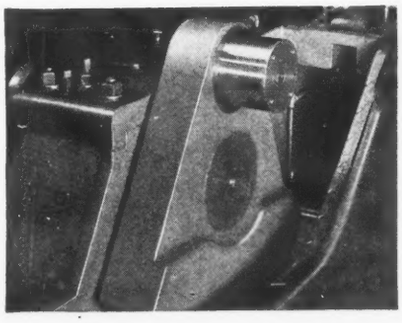


Adjustable cut-off

An improved safety feature of Elliott adjustable cut-off engines is the use of a double silent chain drive for the governing mechanism. Improvements in the link mechanism allow the engine to run at maximum speed.

advances in ELLIOTT ENGINES for 1937



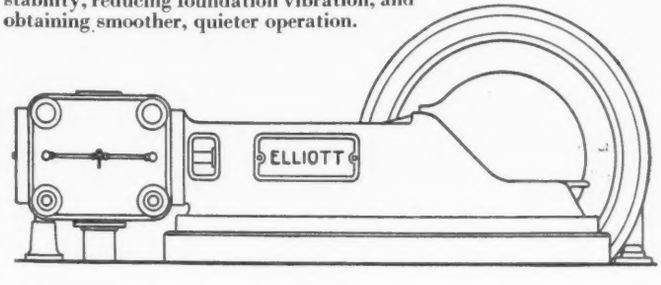


Large crank pin

and crosshead pin reduce bearing pressure, wear, and maintenance. Cast integral with the disc, these large crank pins actually strengthen the disc instead of weakening it as does an inserted pin.

Low center of gravity

As with automobiles, a low center of gravity is an advantage even with stationary steam engines. The center of gravity of Elliott engines has been lowered in the interests of improving stability, reducing foundation vibration, and obtaining smoother, quieter operation.



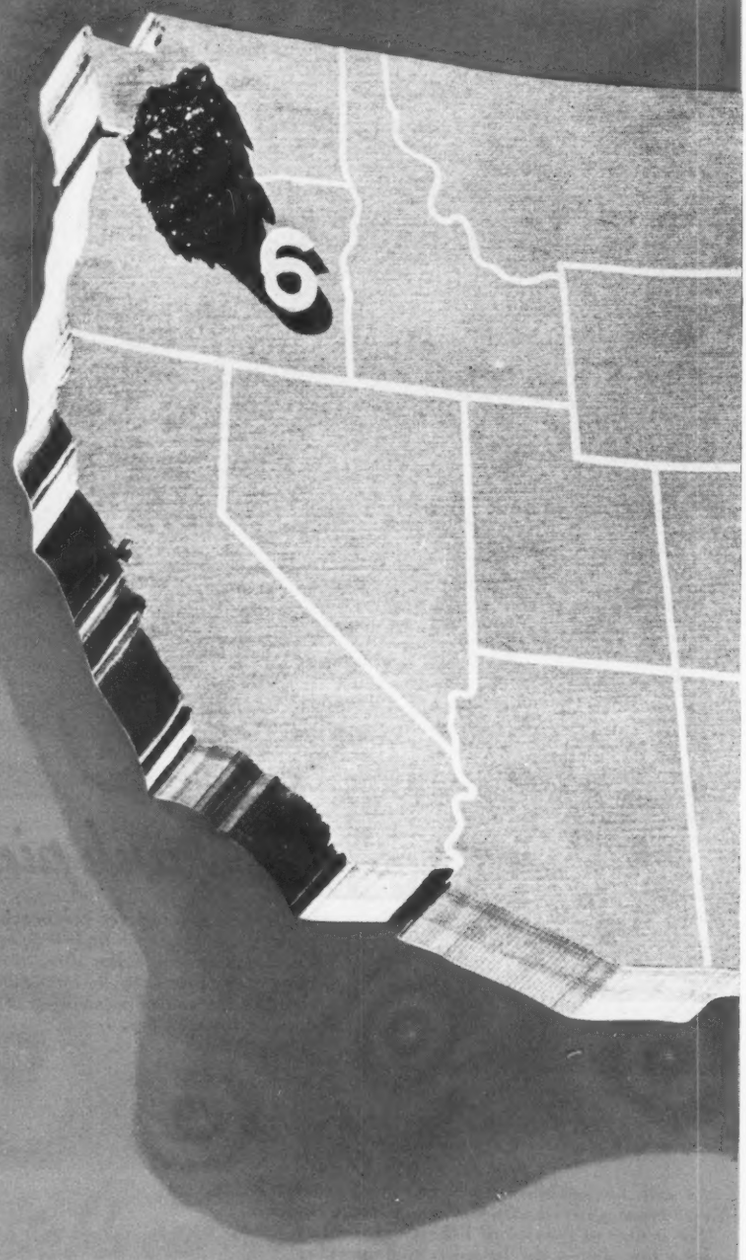
"Always something better" is the watchword of progress. With Elliott steam engines, recent progress has been concerned with the refinements of numerous details. Taken together these refinements add up to a better, smoother-running, and more trouble-free engine.

Added to the already efficient design and sturdy construction of Elliott engines, these developments are significant. A few of these details are shown here, but they are more fully listed and described in a new bulletin. Write for this bulletin — and use the willing co-operation of Elliott sales engineers to assist in selecting the type of engine — single-valve or four-valve counterflow, poppet-valve or Corliss-valve unaflow — which your conditions require.

B-315

ELLIOTT COMPANY
PITTSBURGH, PA.
Steam Engine Dept.
RIDGWAY, PA.
DISTRICT OFFICES IN PRINCIPAL CITIES

The adaptability of the Taylor Stoker makes



There are, in the United States, six great coal fields—furnishing most of the steam coals the power plants of this country consume. The B.T.U. value and ash content of these coals vary widely, roughly from 8,500 to 14,500 B.T.U. per pound as fired and from 40 to 5% respectively. Comparable differences are likewise found in the sulphur content and ash fusing temperatures.

Taylor stokered central stations and privately operated plants are generously peppered throughout each of the six areas and between them. These Taylor Stokers are not only able to burn efficiently coal local to them but their adaptability makes it possible to switch on occasion from the coal of one area to that of another, to take advantage of any favorable price differential, freight included. Why?—because Taylor Stokers are so readily adjusted for any particular coal and because no special preparation is required before the coal is burned. One plant in Ohio, for example, has successfully burned 21 different coals—and burned them at an efficiency justifying their use.

This adaptability of the Taylor Stoker is not happenstance. It is one result of 30 years' experience accumulated by the world's largest engineering force devoted exclusively to the development of multiple retort underfeed stokers.

DIVISION: American Engineering Company, Aramingo Avenue, Philadelphia. IN CANADA: Affiliated Engineering Corporations, Ltd., Montreal, P. Q. OTHER PRODUCTS: A-E-CO Le-Hed Monorail Electric Hoists, A-E-CO Hele-Shaw Pumps, Motors and Transmissions, A-E-CO Marine and Yacht Auxiliaries

THE

you independent of your coal source
2
3
4
5
A-E-CO
TAYLOR STOKER UNIT
TAYLOR STOKERS • A-E-CO WATER WALLS • A-E-CO ASH HOPPERS

THE MARK OF "YARWAY EQUIPPED"

YARWAY BLOW-OFF VALVES

Save steam, trouble, money CATALOG NO. B-417

YARWAY WATER COLUMNS AND GAGES

Positive protection against high or low water CAT. NO. WG-1803

YARWAY IMPULSE STEAM TRAPS

Six sizes serve practically all trap needs CAT. NO. T-1720

YARWAY INVOLUTE SPRAY NOZZLES

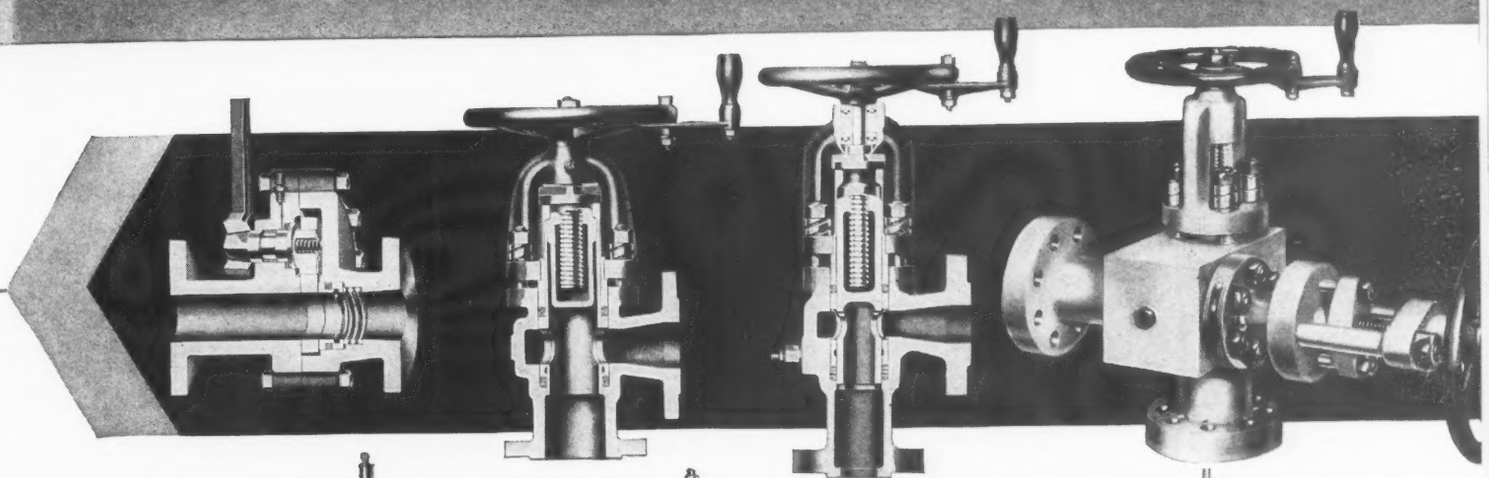
No internal parts or vanes—Non-clogging CATALOG NO. N-613

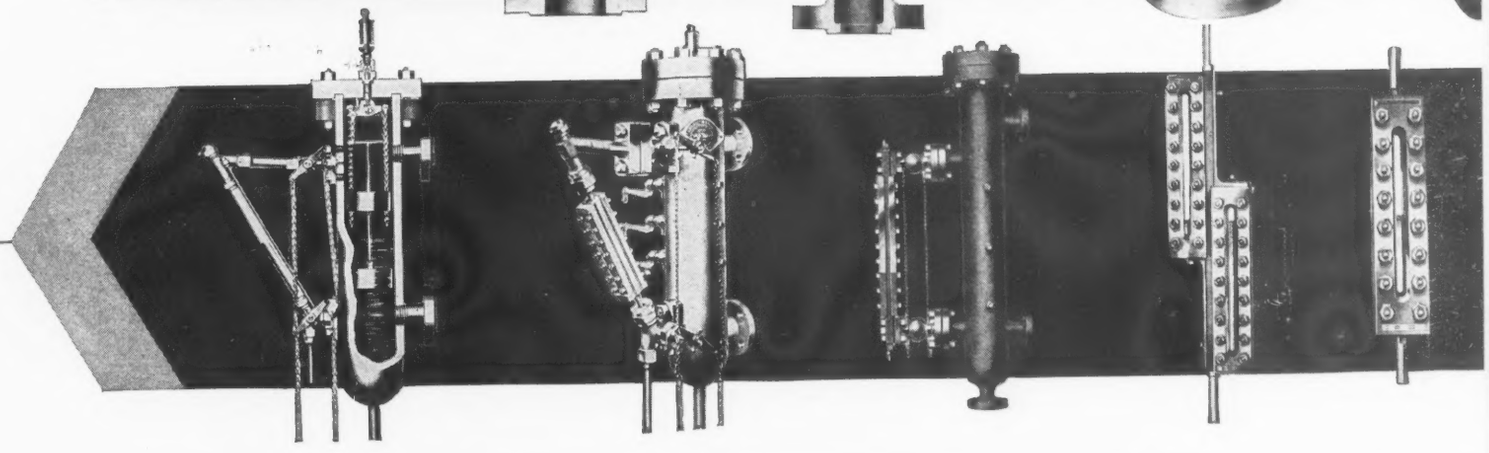
YARWAY EXPANSION JOINTS

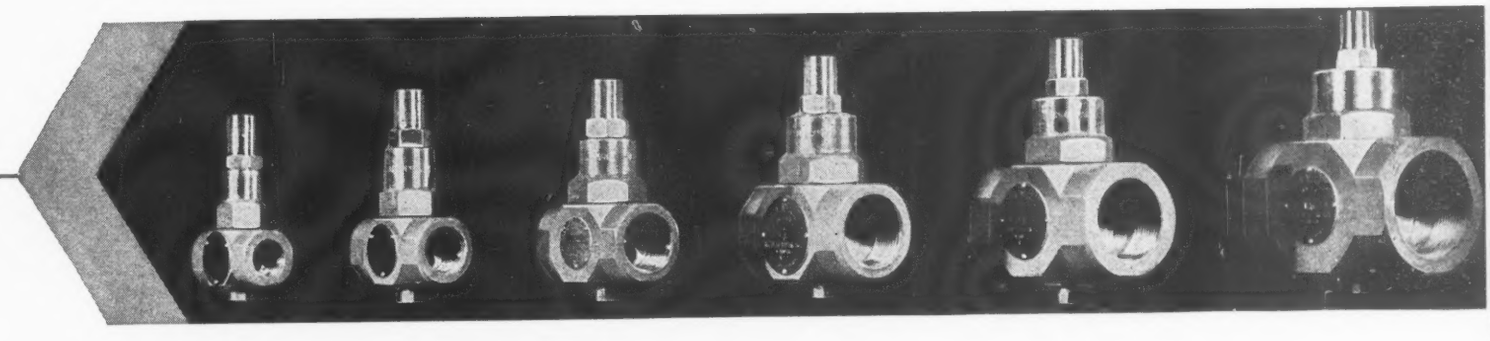
Gun pakt and gland pakt types CATALOG NO. EJ-1904

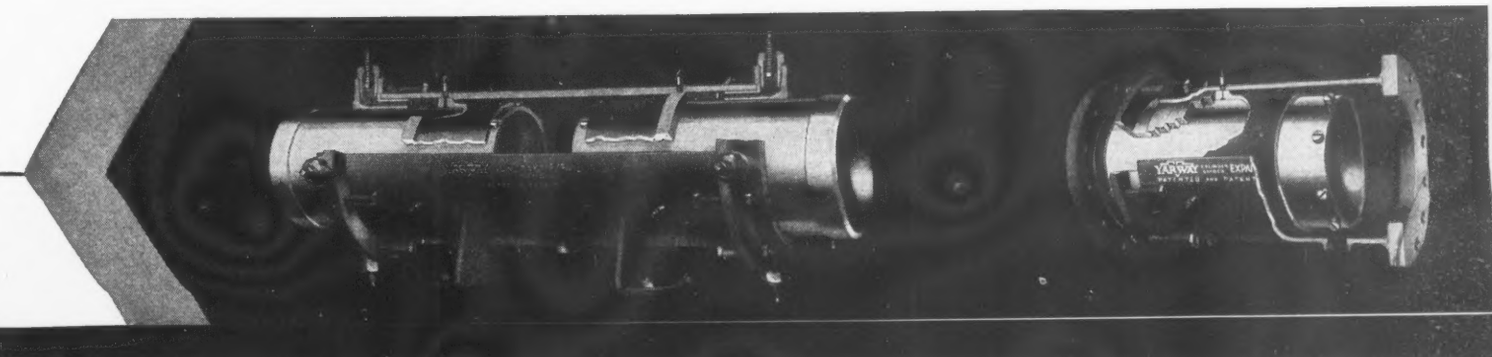
YARNALL WARING CO., MERMAID AVE., PHILADELPHIA

GOOD ENGINEERING



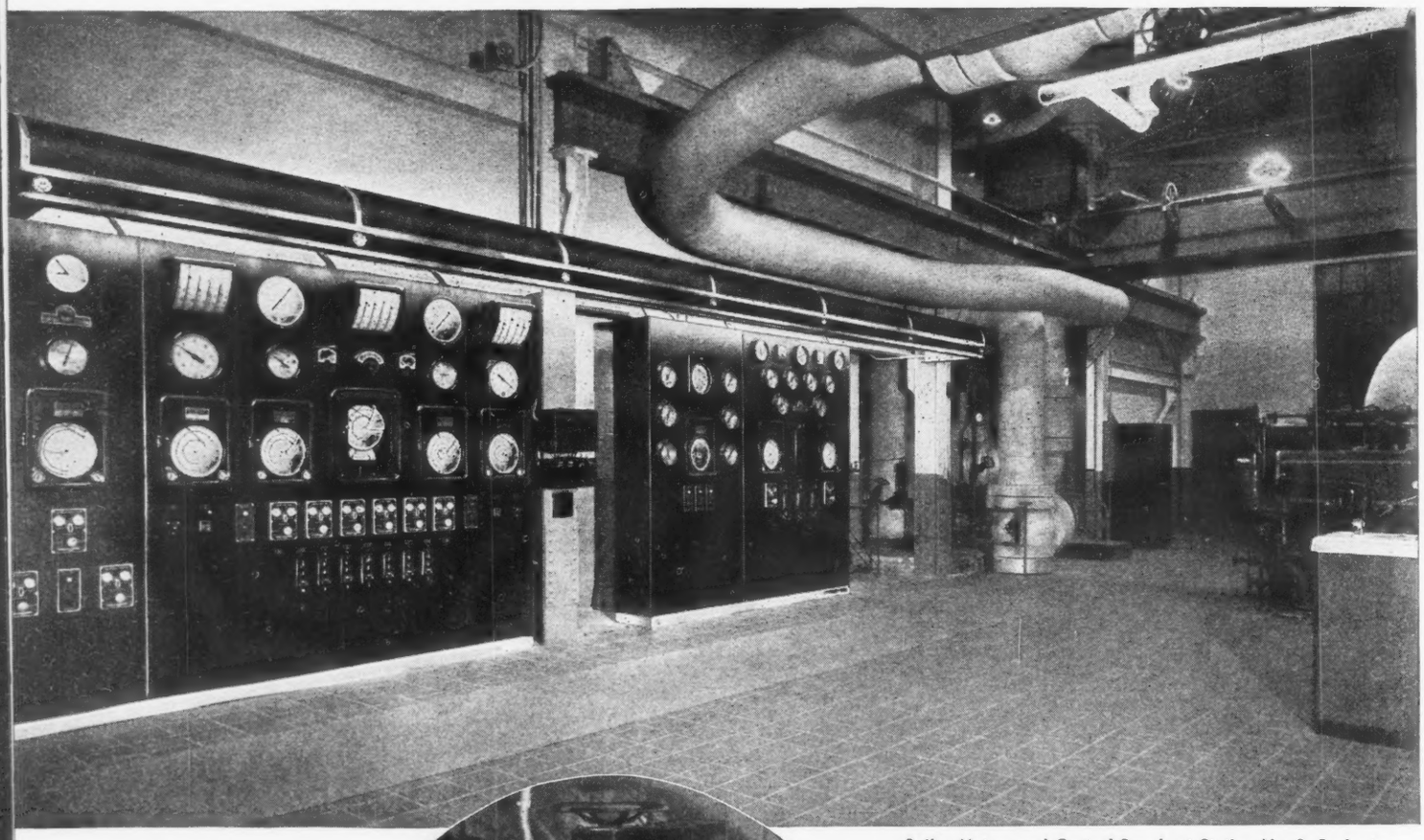




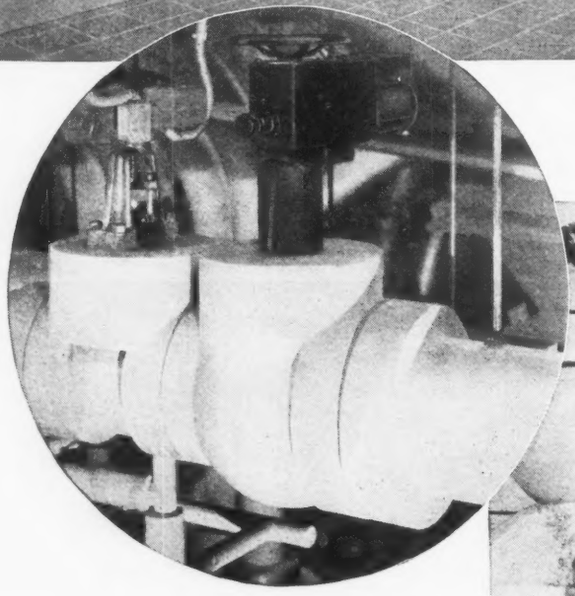


ROCHESTER *again*

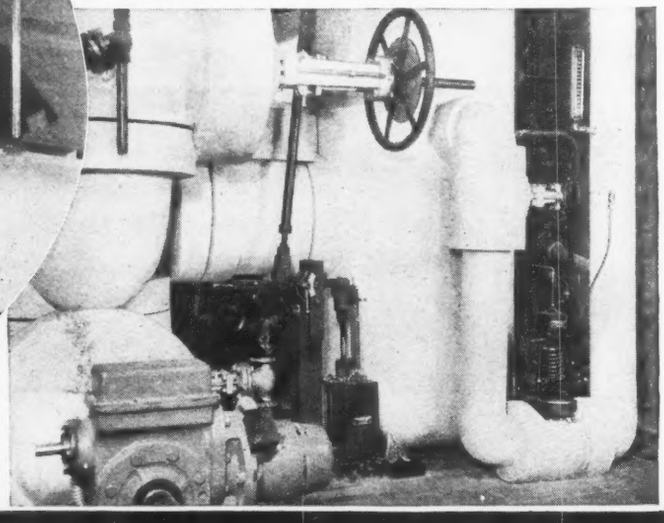
with Bailey Meter Control of:



Bailey Meters and Control Panels at Station No. 3, Rochester Gas & Electric Corp., Rochester, N. Y. Measuring elements for the Combustion Control, the Three-Element Feed Water Control, the Feed Water Pump Control, the Desuperheat Control, and the Pressure Reducing Control are installed on these panels.



Bailey Air-Operated Steam Pressure Reducing Valve.



Bailey Control System Installed on Desuperheater.

BAILEY METER

for AUTOMATIC *Steam*

INSURES TEST RESULTS

COMBUSTION • FEED WATER FLOW • FEED WATER EXCESS PRESSURE • DESUPERHEATING • PRESSURE REDUCING

• Continuous test results from the second high pressure boiler at Rochester Gas & Electric Corporation Station No. 3 will be insured by a complete installation of Bailey Meters and Bailey Meter Control.

Bailey Three-Element Control regulates feed water input to the new 250,000 lb. per hour capacity boiler so that it parallels steam output and provides means to offset the effects of "swell" and "shrinkage" by varying boiler drum water level.

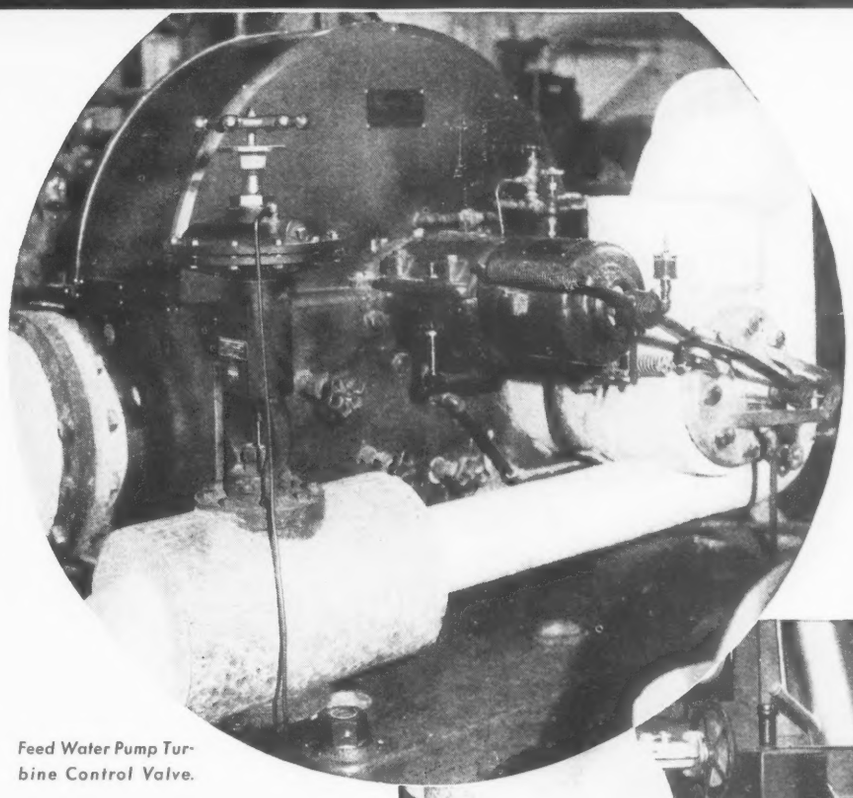
Feed water pump speed is regulated by a Bailey Excess Pressure Control System.

The Bailey Combustion Control not only maintains steam pressure but also automatically readjusts air to constantly maintain maximum combustion economy. Close control of fuel-air ratio and furnace draft results in maximum heat absorption efficiency.

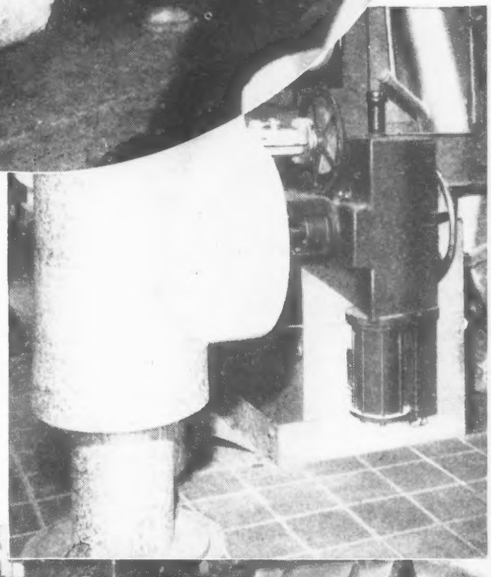
Desuperheating and Pressure Reducing Bailey Control Systems insure proper conditioning of steam for low pressure service.

Case histories of savings effected by Bailey Meters and Control will be furnished without obligation.

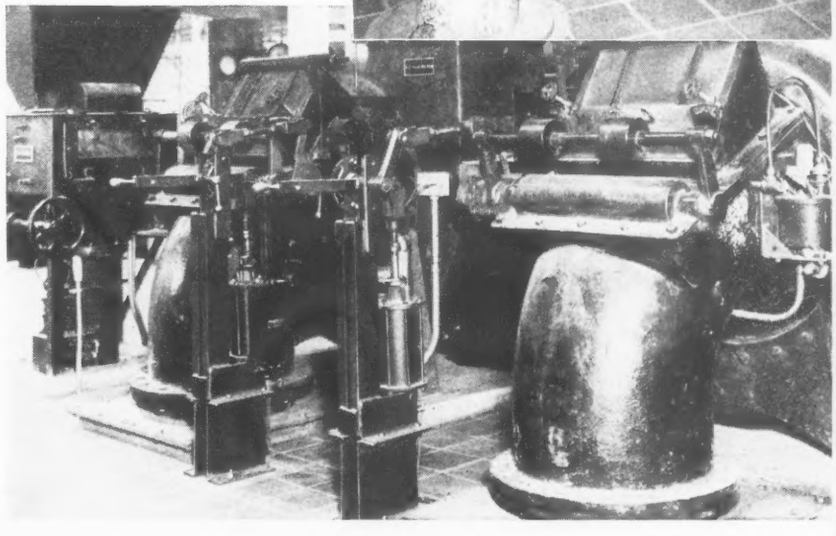
BAILEY METER COMPANY
1025 IVANHOE ROAD • CLEVELAND, OHIO
Bailey Meter Company Limited, Montreal, Can.
A-16



Feed Water Pump Turbine Control Valve.



Bailey Three-Element Air-Operated Feed Water Control Valve Installed in Feed Water Line.



Air-Operated Drives Controlling Fuel Supply.

CONTROL

BAILEY METER CONTROL SYSTEM

Generation and Utilization

WHEN YOU INSTALL G-E MIDGET
One of the Best Types of Production

COMPACT

Height: 64 inches
Width: 22 inches
Depth: 48 inches

MODERATE COST

The cost of the midget metal-clad compares favorably with that of switching equipment purchased and installed piecemeal.

MINIMUM INSTALLATION COST

You receive the midget metal-clad completely assembled—just set it in position and connect the cables.

BETTER APPEARANCE

Instruments and devices mounted semiflush to give streamlined appearance. Standard units without panels also available.

SAFETY

When breaker is lowered from operating position, the circuit is automatically interrupted inside the breaker. All live parts are completely enclosed in grounded steel compartments.

CONVENIENCE

Circuit breaker can be completely removed from housing in a few moments for inspection.

PROPER OPERATION

A system of interlocks prevents incorrect operation and possible damage to machines.

MOBILITY

The midget metal-clad unit can readily be moved to a new location at any time.

LOW MAINTENANCE

Silver contacts in the breaker and silver disconnecting devices minimize maintenance.

GENERAL ELECTRIC

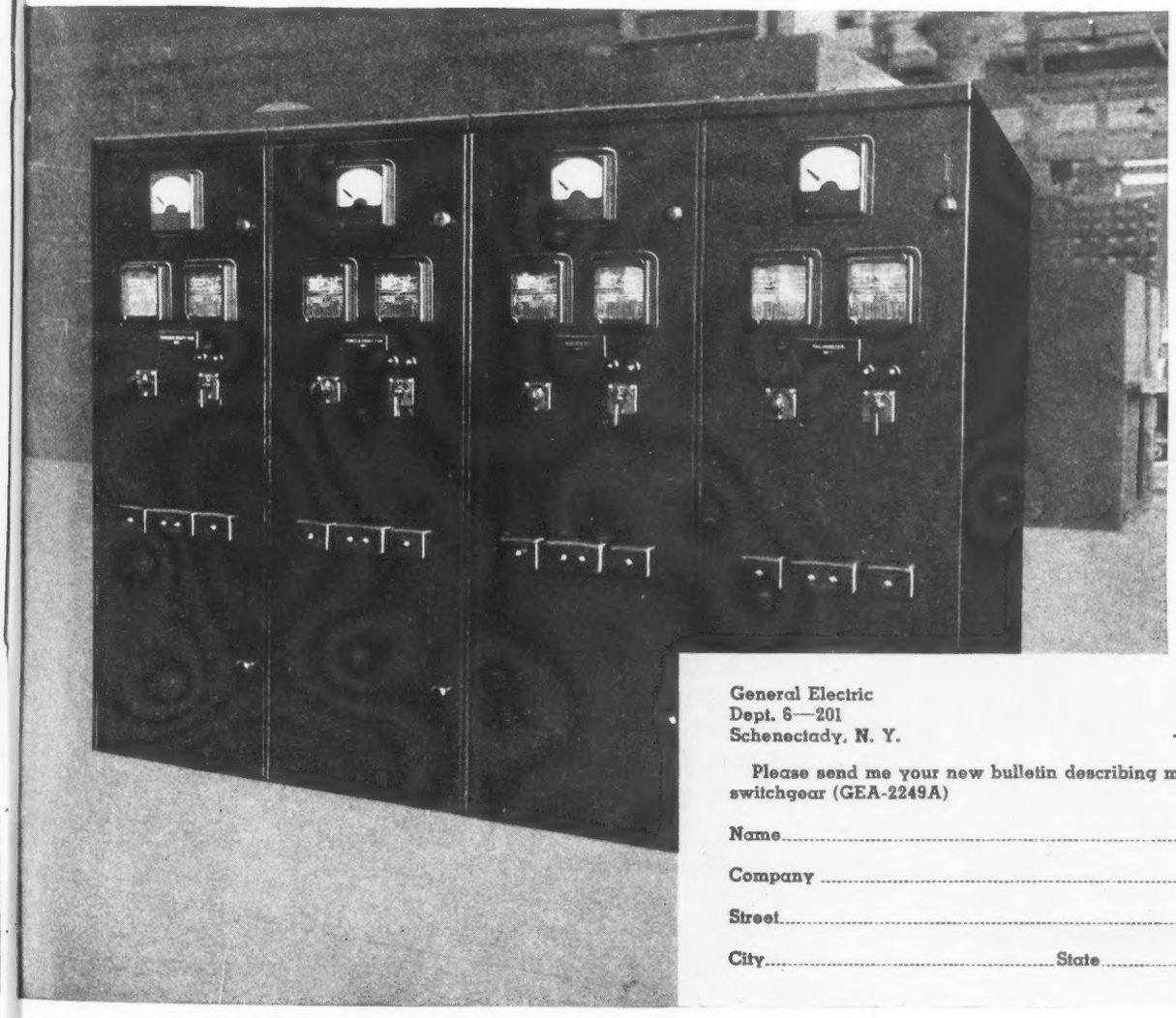
METAL-CLAD SWITCHGEAR, You Get Insurance That You Can Buy

BECAUSE you are giving your electric circuits and production machinery the swift, sure protection of a famous G-E oil-blast circuit breaker—similar in design to the heavy-duty breakers that power companies, steel mills, and other large industrials rely on for the protection of their highest-capacity electric circuits and equipment.

The midget metal-clad is safe—all live parts are completely enclosed—a system of interlocks guards against incorrect operation.

You will get other advantages, too. It cuts installation costs—you receive it completely assembled, ready to connect. It can readily be moved to a new location should that be desirable. It is moderate in cost.

Why not investigate the profitable possibilities of installing G-E midget metal-clad units in your plant? They are available for services up to 5000 volts; interrupting ratings up to 50,000 kva. For higher-capacity, heavy-duty jobs, rely on the G-E master metal-clad—Type MI-6. Mail the coupon today for complete information. General Electric Company, Schenectady, N. Y.



Four G-E midget metal-clad units with streamlined control panels—instruments and devices mounted semiflush

General Electric
Dept. 6—201
Schenectady, N. Y.

Please send me your new bulletin describing midget metal-clad switchgear (GEA-2249A)

Name.....

Company.....

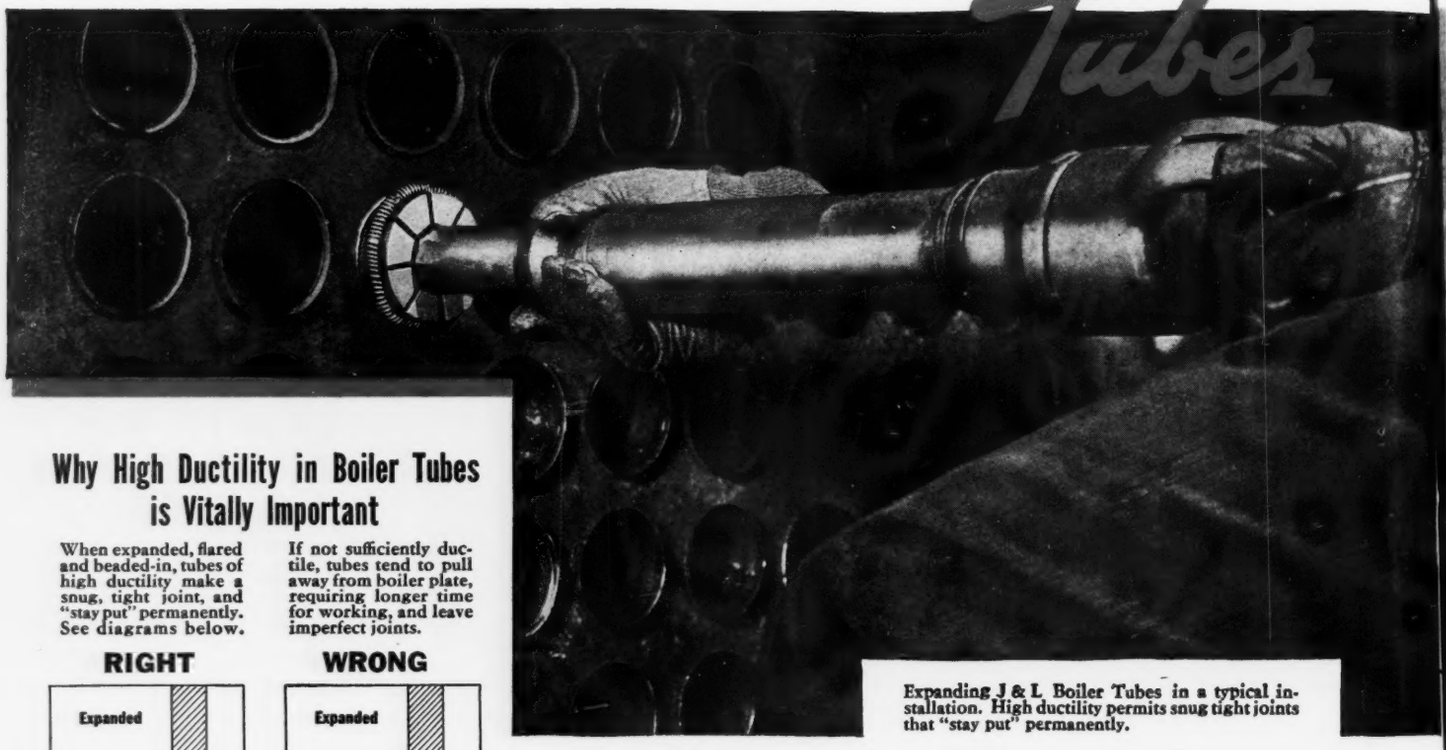
Street.....

City..... State.....

880-10

Cut Installation and

with J & L Seamless Steel *Boiler Tubes*

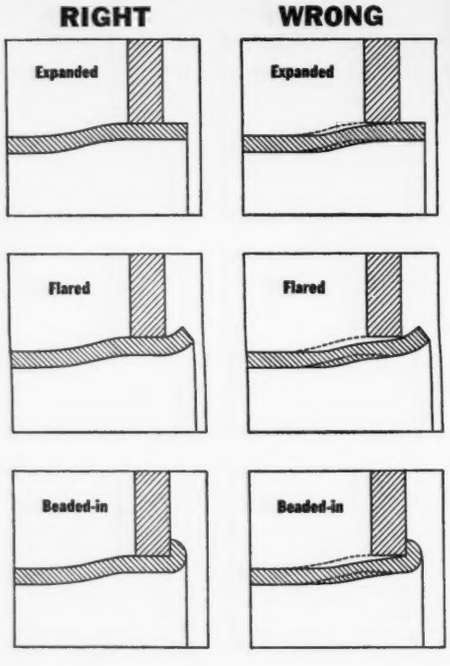


Expanding J & L Boiler Tubes in a typical installation. High ductility permits snug tight joints that "stay put" permanently.

Why High Ductility in Boiler Tubes is Vitally Important

When expanded, flared and beaded-in, tubes of high ductility make a snug, tight joint, and "stay put" permanently. See diagrams below.

If not sufficiently ductile, tubes tend to pull away from boiler plate, requiring longer time for working, and leave imperfect joints.



YOU save time and money on every boiler tube installation when you use J & L Seamless Steel Boiler Tubes. They are made of high quality, easy working steel, and they stay put when expanded, flared, and beaded-in. As a result they are installed with a minimum of time and expense, and maintenance costs are unusually low.

The easy workability or high ductility of J & L Seamless Steel Boiler Tubes is the direct result of the effective forging action which characterizes the Jones & Laughlin method of manufacture.

There can be no failure at—or near—a weld, *because there are no welds.*

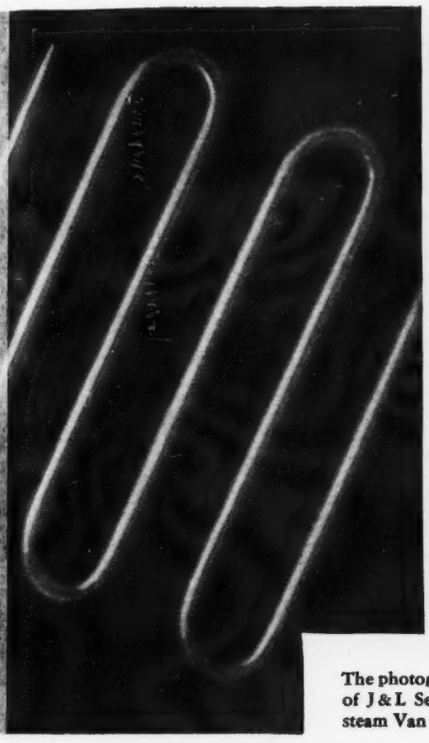
J & L Boiler Tubes meet all standard specifications and they are widely used in both fire tube and water tube types of boilers.

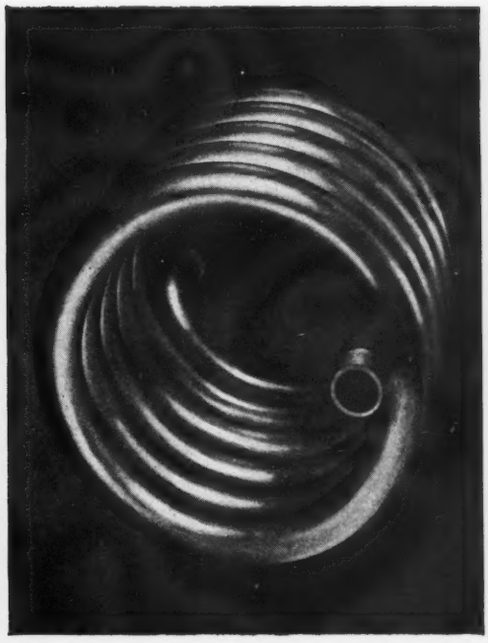
Specify J & L Seamless Steel Boiler Tubes. You will save on both installation and maintenance costs, and you will be sure of long trouble-free service. Order from your J & L Boiler Tube distributor.

J&L STEEL

Maintenance Costs

. . . with J & L Seamless Steel *Pipe*





The photographs, left and center above, illustrate the bending and coiling qualities of J & L Seamless Steel Pipe. The photograph at the right shows a high pressure steam Van Stone Joint made of extra heavy J & L Seamless Pipe.

J & L Seamless Steel Pipe meets every requirement for strength, safety and service. It has the proper ductility for easy workability. It has uniform wall thickness and strength for safe, dependable service in high pressure installations. And it has the uniformity of quality that insures long trouble-free performance.

J & L Seamless Steel Pipe offers these important advantages because of the high quality built into it at the mill. It is made of selected steel, under strict metallurgical control, and every length is tested and inspected to make sure that it measures up to Jones & Laughlin's traditionally high standard of quality.

Specify J & L Seamless Steel Pipe for your power piping. It will give you long satisfactory service and will save time and money for you in both installation and maintenance.

J & L TUBULAR PRODUCTS

Jones & Laughlin manufactures a complete line of seamless and welded steel tubular products, including seamless pressure tubes, condenser tubes and heat exchanger tubes.

SEND FOR FREE COPIES OF:

J & L Seamless Steel Boiler Tube Bulletin, containing specifications and complete information on J & L Boiler Tubes.

J & L PIPE HANDBOOK, SP-3, containing application data on J & L Steel Pipe for engineers and contractors.

JONES & LAUGHLIN STEEL CORPORATION

AMERICAN IRON AND STEEL WORKS

JONES & LAUGHLIN BUILDING, PITTSBURGH, PENNSYLVANIA

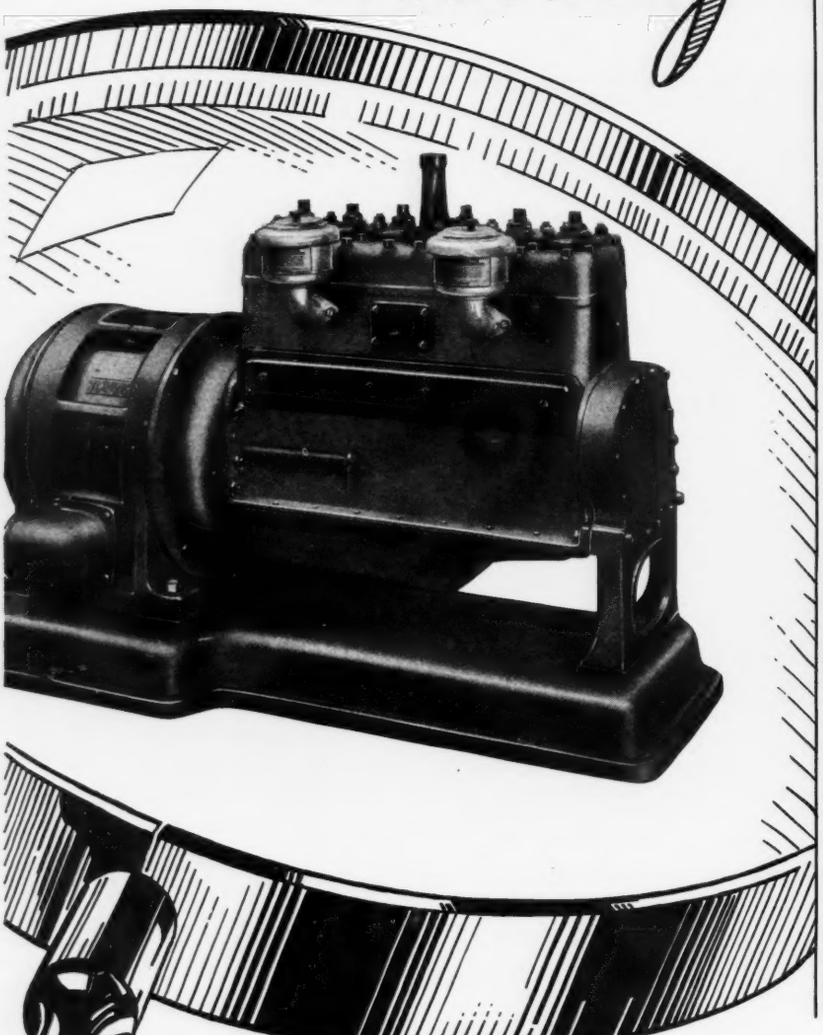
Sales Offices: Atlanta Boston Buffalo Chicago Cincinnati Cleveland Dallas Denver Detroit Erie Houston Los Angeles Memphis Milwaukee Minneapolis New Orleans New York Philadelphia Pittsburgh Seattle St. Louis San Francisco Tulsa

Warehouses: CHICAGO CINCINNATI DETROIT MEMPHIS NEW ORLEANS NEW YORK (Long Island City)* PITTSBURGH

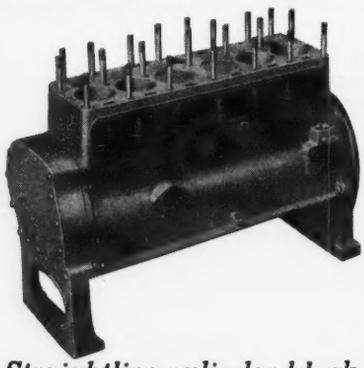
*Operated by National Bridge Works Division of Jones & Laughlin Steel Service, Inc.

Canadian Representatives: JONES & LAUGHLIN STEEL PRODUCTS COMPANY, Pittsburgh, Pa., U. S. A., and Toronto, Ont., Canada

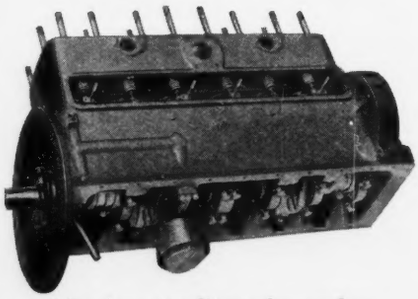
LOOK INTO THE SCHRAMM *Utility*



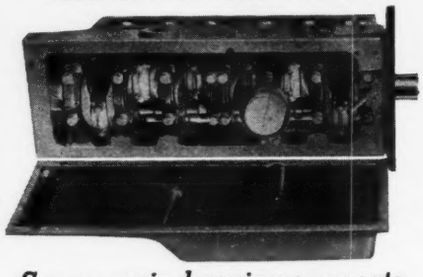
Large removable valves



Straightline cylinder block



Mechanical intake valve



Seven main bearing supports

MODERNIZE your air compressor equipment. Install the SCHRAMM "Utility"—the "world's most modern air compressor". Sizes up to 600 cu. ft. displacement. Any drive. WRITE FOR NEW BULLETIN 3616-PD.

SCHRAMM, INC., WEST CHESTER, PENNA.

SCHRAMM AIR compressors

RUBBER RIDES THE RAILS

As Well As The Highways

A typical example of Goodrich product development

A FEW short years ago, railroads faced a real problem. Speed was the demand of the times—but extreme train speed brought quick wear, vibration, noise.

But railroad engineers were at work. They called on the metallurgists for more alloys, and on Goodrich for new rubber properties.

Goodrich was ready. Sixty-five years of research could now be applied to railroad problems.

Rubber center plates were developed to reduce transfer of noise and vibration from trucks to body. Side-sway on curves was steadied by rubber side bearings. Special rubber strips were made to insulate cars against heat, noise and dirt. Motors and air-conditioning mechanism were mounted on rubber to isolate the body against vibration.

More recently rubber tie plates have been developed to reduce shock caused by rail joints and cross-overs.

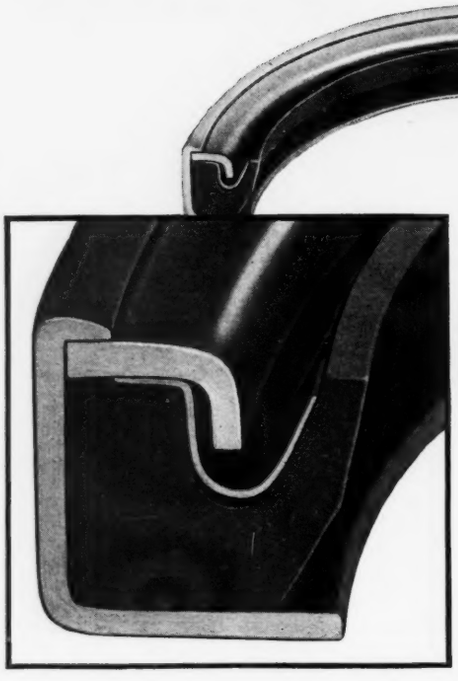
The result of such development is the quiet, speedy train of today—rejuvenating rail travel, setting new speed records, reviving the railroads' place in the sun. Goodrich improvements in rubber played their important part in making this modern marvel practical—just as Goodrich improvements in belting, hose and other rubber products have brought increased efficiency and greater economy to industry. The B. F. Goodrich Company, Akron, Ohio.

Goodrich

ALL *products problems* IN RUBBER

YOU'RE LOOKING FOR A BETTER OIL SEAL?

Here it is!



PATENTED

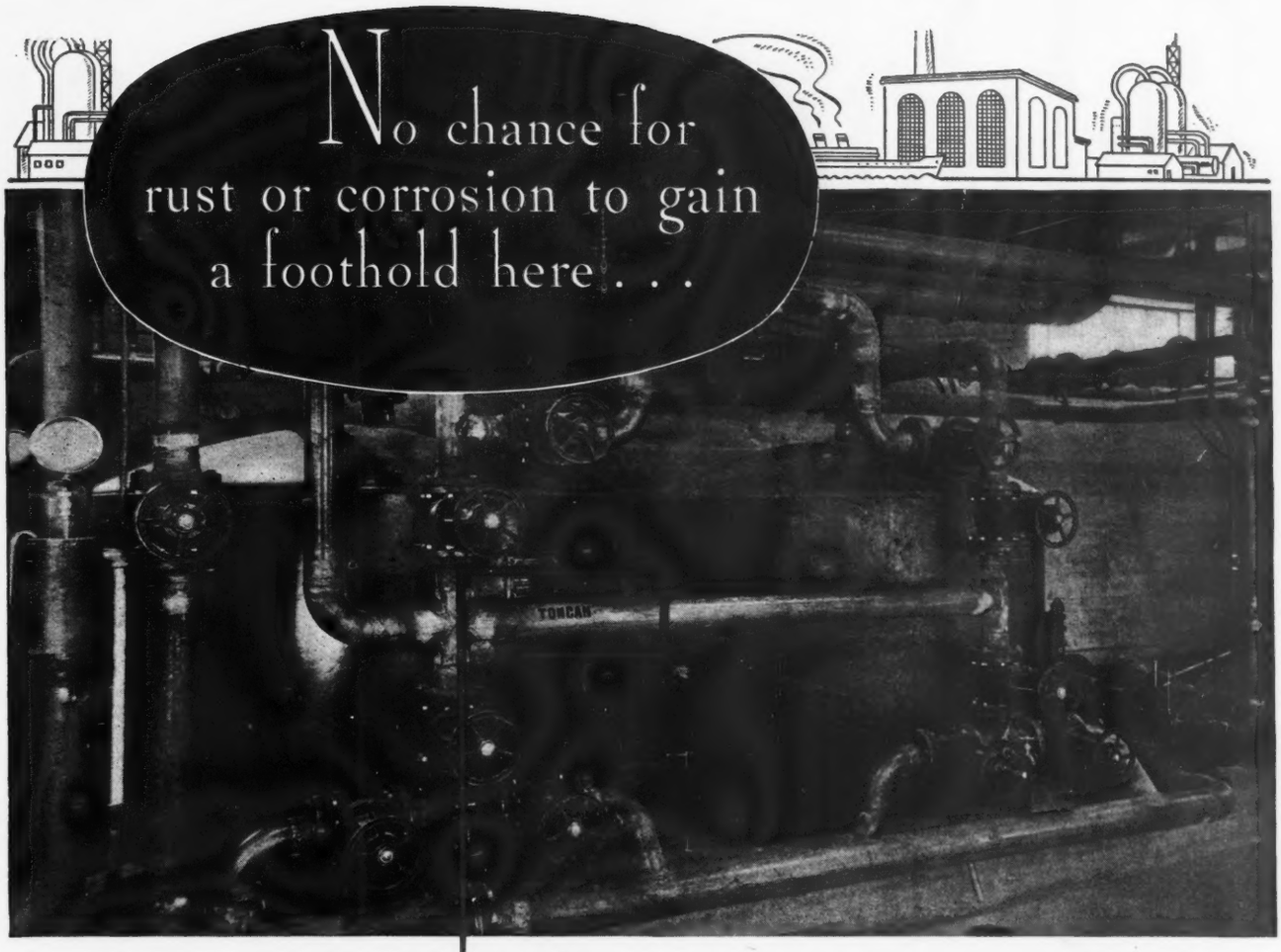
THE *Garlock* KLOZURE

The GARLOCK KLOZURE consists of only four parts as illustrated above. It is simple in construction and effective in use. Performance is uniform and dependable.

YOU won't need to look far, if you're looking for a better oil seal. Just phone the GARLOCK representative and he will tell you why thousands of users have found the GARLOCK KLOZURE a *superior* oil seal. The KLOZURE sealing ring is a special GARLOCK compound—dense, grainless, tough. It *resists* oil and water at high and low temperatures . . . does not become soft and flabby. GARLOCK KLOZURES are made in a complete range of sizes and for every type of oil seal application. Write for booklet.

THE GARLOCK PACKING CO., PALMYRA, NEW YORK
In Canada: The Garlock Packing Company of Canada, Ltd., Montreal, Que.

GARLOCK



THE JOB IS 100% *TONCAN IRON*

● Here is an example of sound, economical engineering—an all-Toncan Iron piping system. Rust has no opportunity to creep in and destroy—for the pipe and fittings, even the welding rod used, is Toncan Iron—the alloy of refined open-hearth iron, copper and molybdenum that resists rust and corrosion better than any ferrous material in its price class.

Wise engineers in every branch of industry are following this same practice today—and thereby saving piping worries and expense later on. They use Toncan Iron Pipe for boiler feed, condensate and blow-off lines, for salt water and brine lines, for process piping, for acid sludge and crude oil lines—for all types of installations in which less resistant pipe is expensive to use because of severe conditions and resultant short service life. And they go a step further by using the same corrosion-resisting material for fittings.

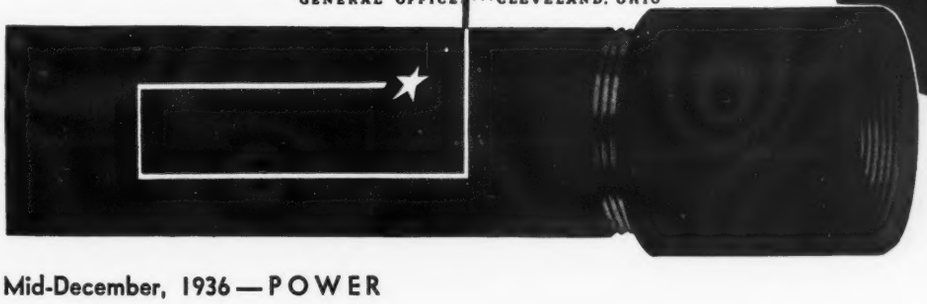
You need not experiment with Toncan Iron Pipe—service records from all classifications of industry have proved its dependability and economy. And what others have done with this rust-resisting pipe, you can do, too. Write for a copy of "Pipe for Permanence."

REPUBLIC STEEL

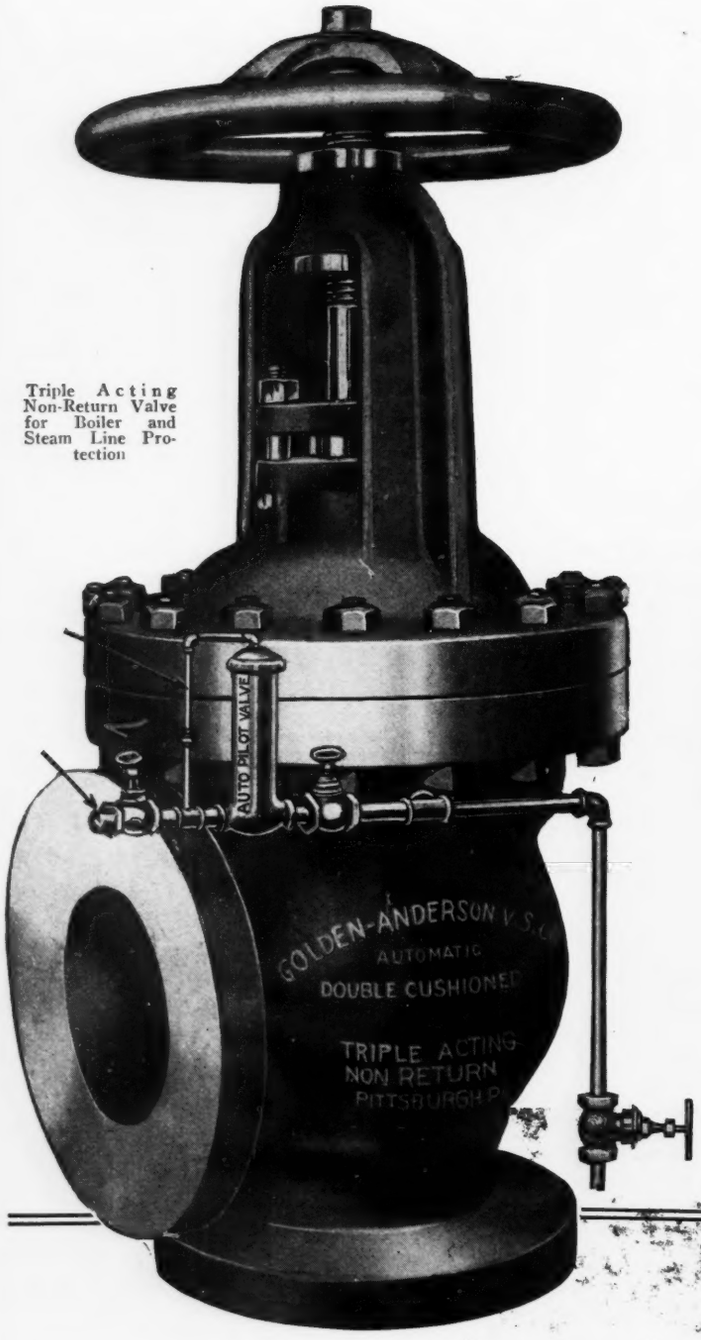
Look to Republic as a major source of supply for butt weld, lap weld and electric weld pipe—made of carbon steel, copper-bearing steel and Toncan Copper Molybdenum Iron.

Republic Steel
CORPORATION
GENERAL OFFICES · · · CLEVELAND, OHIO

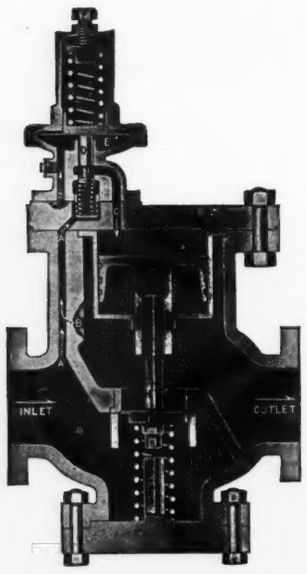
REG. U.S. PAT. OFF.
TONCAN
COPPER
MO-LYB-DEN-UM
IRON PIPE



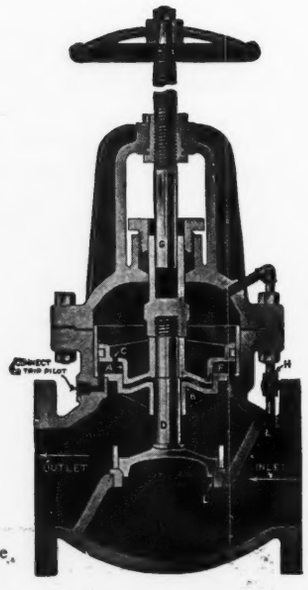
Golden-Anderson Steam



Triple Acting Non-Return Valve for Boiler and Steam Line Protection



Steam Pressure Reducing valve



Throttle and Engine Stop valve

GOLDEN-ANDERSON

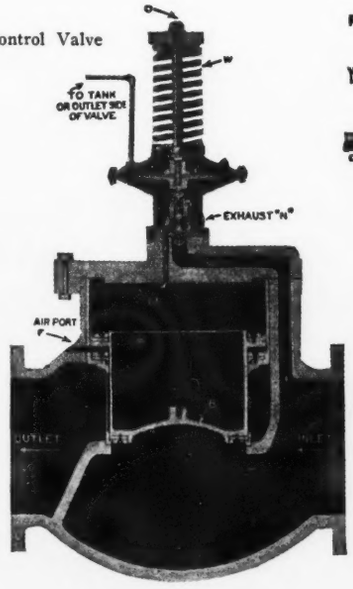
and water service Valves...

THE broad service to industry offered by The Golden-Anderson Valve Specialty Company is the result of over 30 years of manufacturing automatic control valves only.

Golden-Anderson steam and water service valves are effecting economies in plants of every size in practically every industry. As designing engineers, we are able to design and build special valves to meet practically any service requirements you may have.

Without any obligation on your part, a Golden-Anderson engineer will gladly discuss with you any valve problems you may have.

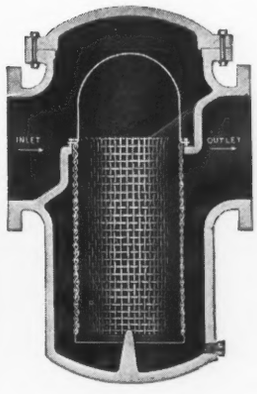
Altitude Control Valve



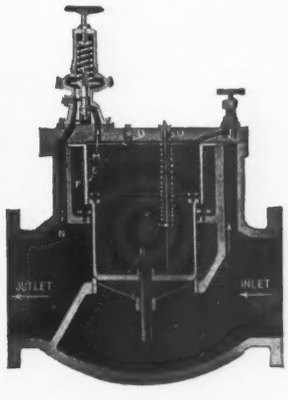
Controlling Float Valve

Write for catalog

Ideal Strainer



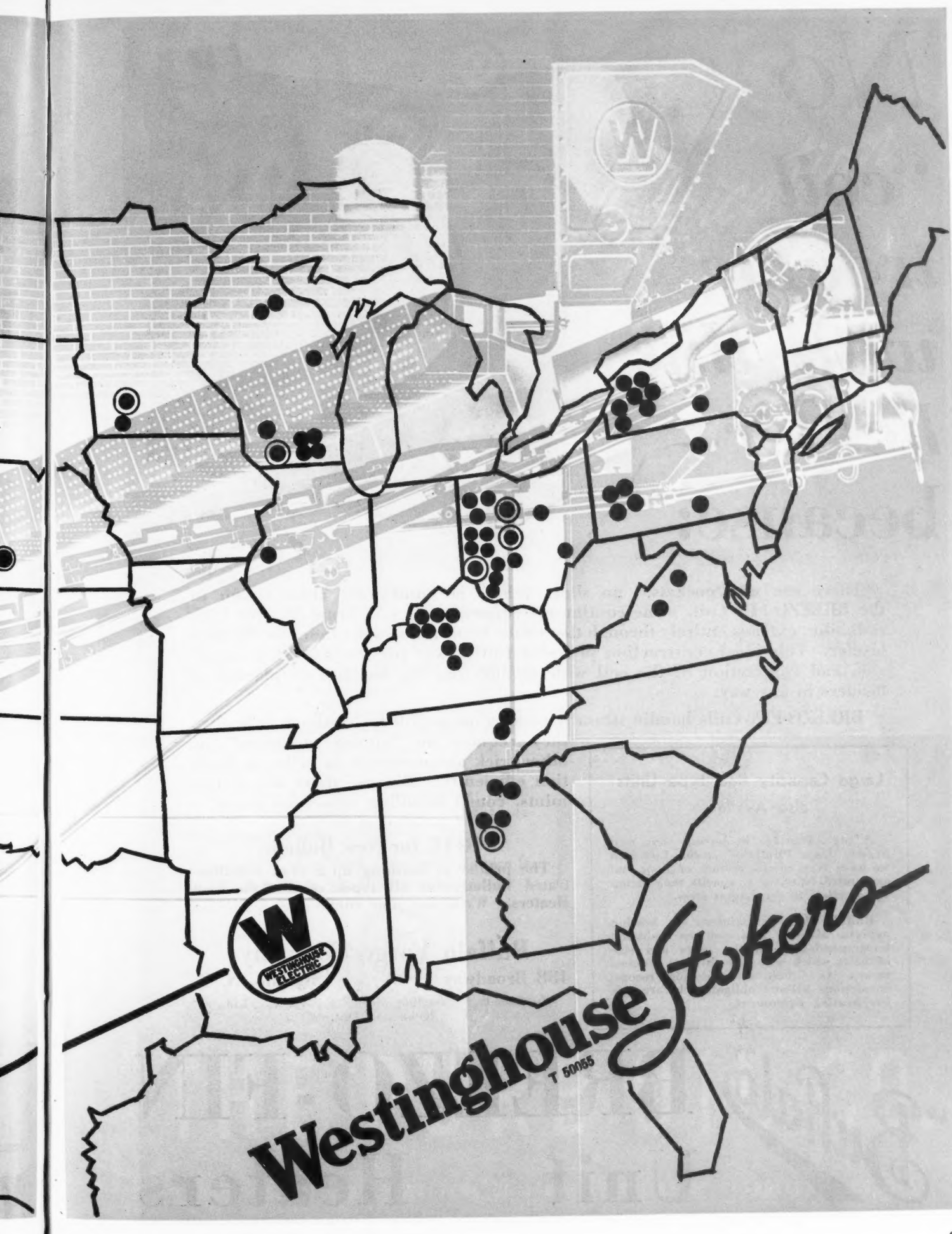
Water Pressure Regulating Valve



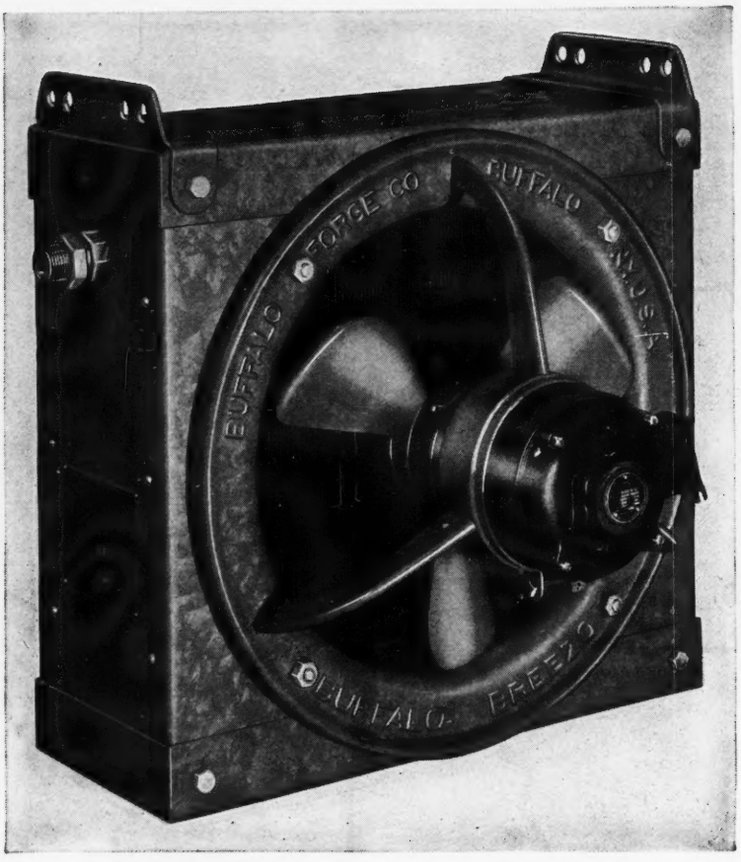
VALVE SPECIALTY CO.

1314 FULTON BUILDING
PITTSBURGH, PENNSYLVANIA

WESTINGHOUSE
CONTINUOUS-ASH-DISCHARGE
Link Grate Stoker
63 STOKERS IN ELEVEN DIFFERENT STATES
7 REPEAT ORDERS
3 EXISTING STOKERS CONVERTED TO THIS TYPE
SUITABLE FOR USE WITH ANY BITUMINOUS COAL


Westinghouse Stokers
T 50065

No "coil trouble" with this heater — because:



There are no "pockets," no short tubes, no multi-joint construction in the BREEZO-FIN Coil. One continuous copper tube, with brass fins for high radiation, extends entirely through the heater from the steam header to the drip header. This ideal construction provides full leeway for the necessary expansion and contraction of the coil without affecting the location or placing of headers in any way.

BREEZO-FIN Coils handle steam pressures up to 250 lbs. without difficulty; they require no "spring mounting" or other trick arrangements in order to function efficiently. Because there are so few joints, rough handling causes no leaks.

Large Capacity floor-type Units also Available

A big advantage in buying your unit heaters from "Buffalo" is the fact that we have very complete lines of floor and suspended types, in a capacity range from the smallest to the largest sizes.

Buffalo Branch Engineers are heating experts, able to give you an unbiased recommendation on the types and size of units which will best fit your requirements. Get their money-saving recommendations without obligation before you buy heating equipment.

WRITE for New Bulletin

The printer is finishing up a new, well-illustrated bulletin on all types of Buffalo Unit Heaters. Write for your copy.

Buffalo Forge Company

488 Broadway **Buffalo, N. Y.**

In Canada: Canadian Blower & Forge Co., Ltd., Kitchener, Ont.

"Buffalo" BREEZO-FIN Unit Heaters

BACK OF IT ALL IS.. *lubrication*

Santa works on a close schedule! The whirring wheels of plant and factory turning out toys and gifts must not slow down. Production and deliveries must be on time.

Shutdowns mean delay in shipments—cancelled orders. Whether at Christmas time or through the rest of the year lubrication must play its vital part.

The Pure Oil Company supplies more than just an industrial lubricant. It offers you its Three Point Service to insure reliable and dependable, as well as economical operation.

Ask a Pure Oil lubrication engineer to call and give you a forecast of your 1937 lubrication requirements.

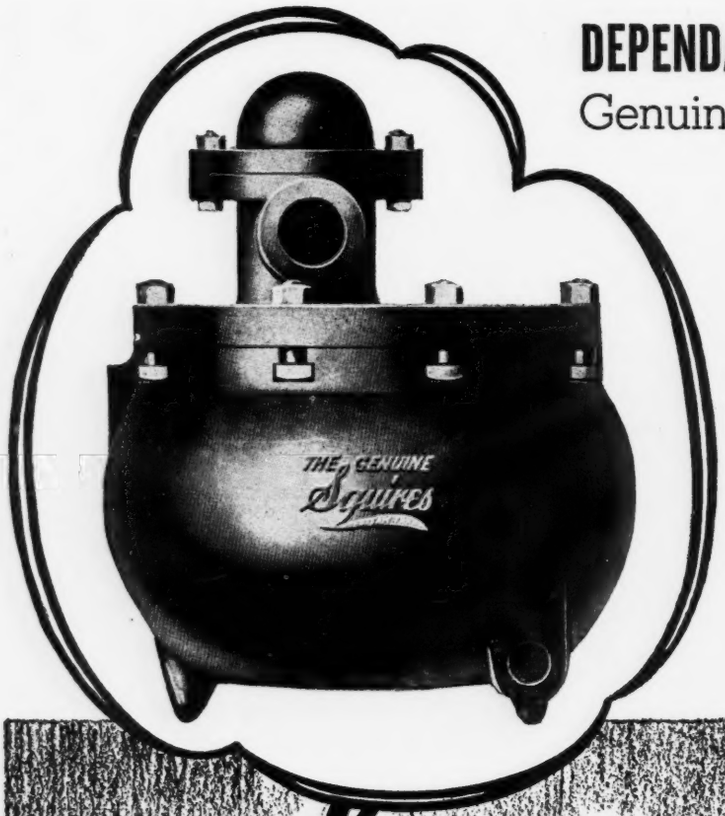
Comprising Pure Oil's Three Point Service is: 1. Selected Crude. 2. Skillful Refining and 3. Scientific Application.

THREE POINT SERVICE — PURE — THE PURE OIL COMPANY, U.S.A.

THE PURE OIL CO.

U. S. A.

PRODUCERS, REFINERS, MARKETERS OF A COMPLETE LINE OF PETROLEUM PRODUCTS



DEPENDABILITY assured with the Genuine Squires Traps Reducing Valves Pump Governors Feed Water Controllers

When power production is interrupted, the entire plant knows about it—and expects the power engineer to do something about it immediately. The full line of GENUINE SQUIRES products are built with the need for dependability constantly in mind.

Squires Traps are designed and built by craftsmen with many years of experience behind them. Action is rapid. They operate on high or low pressure and will handle large volumes of condensate, and simple in construction.

For nearly four decades, Squires Traps have been a standard of reliability.

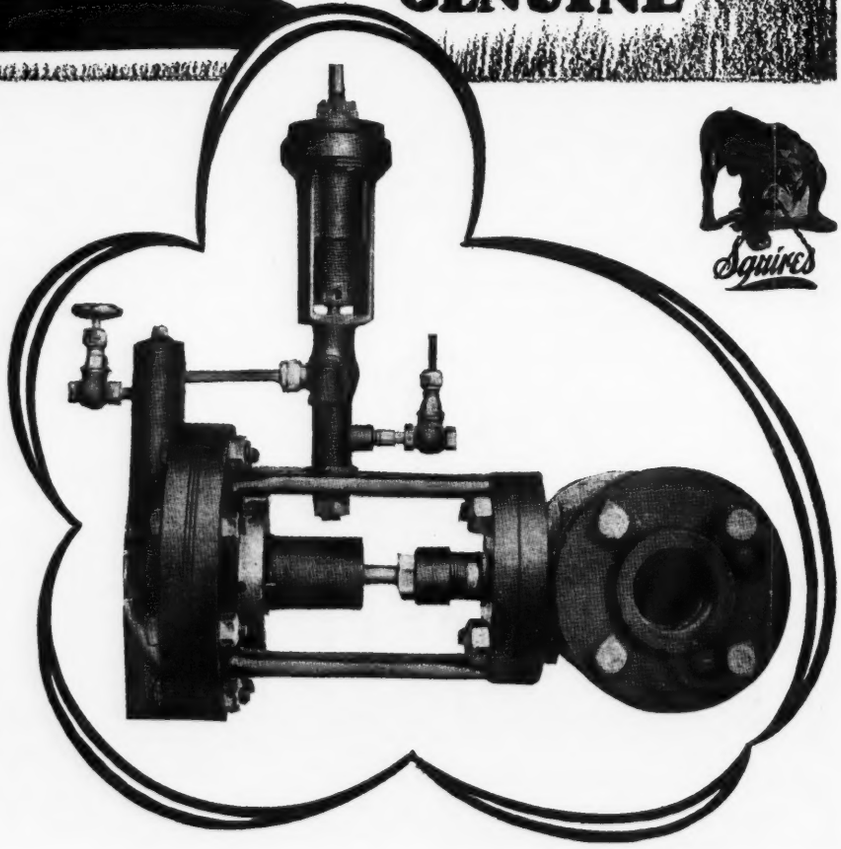
Squires The GENUINE

Reducing Valves

Will reduce from 500 lbs. to one ounce at one step. Wearing parts reduced to a minimum. Valve seats and discs are removable and are accessible without breaking pipe connections.

A DEAD END VALVE sensitive but sturdy—reliable—durable—satisfactory.

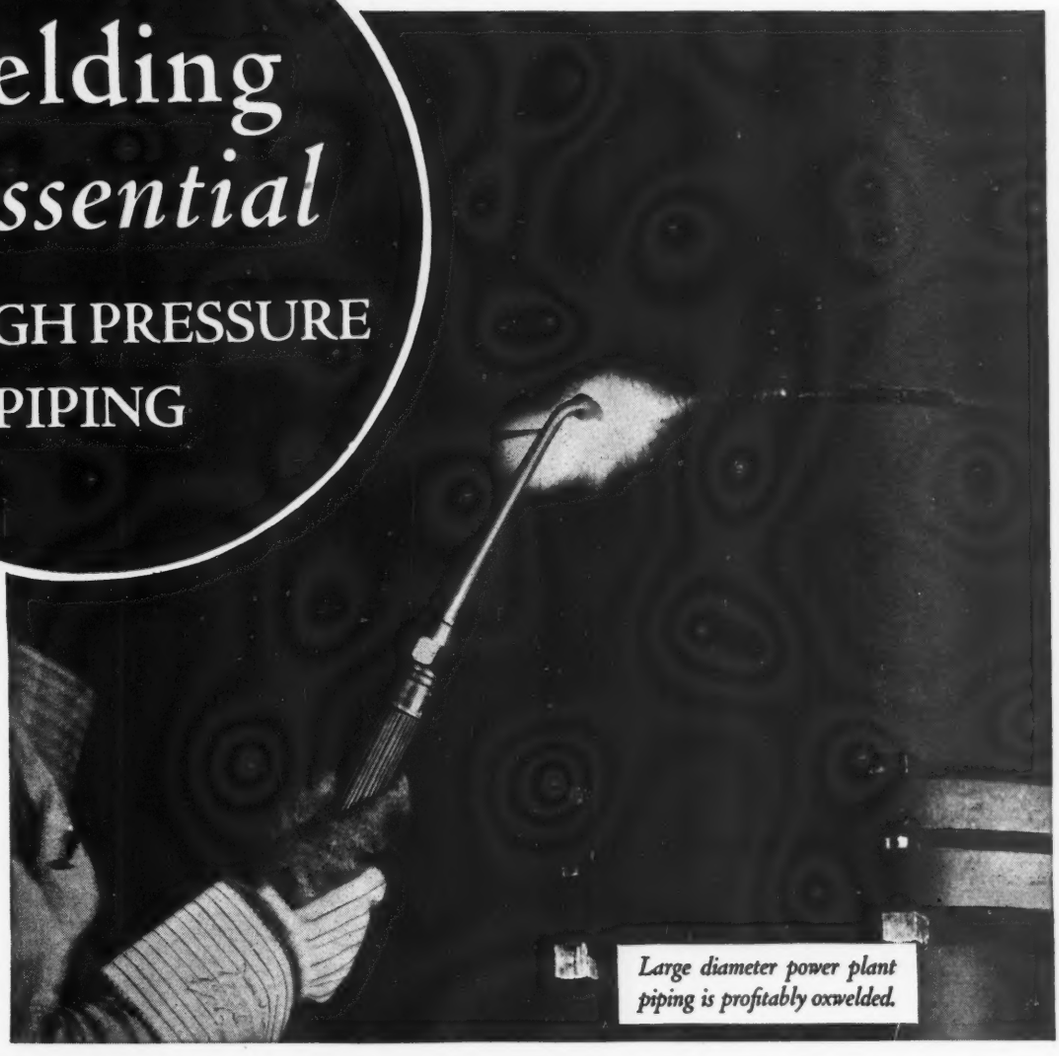
Write for Literature



THE C. E. SQUIRES CO.

East 40th Street & Kelley Ave.
Cleveland, Ohio

Welding *is essential* FOR HIGH PRESSURE PIPING



Large diameter power plant piping is profitably oxwelded.

Oxy-acetylene welding is the modern method of joining piping for steam, compressed air, and other industrial services. Where the service requires high pressure, welding is often the essential element in assuring maximum economy of construction and maintenance. When properly done, welding furnishes a guarantee of tightness and freedom from joint-maintenance.

Linde Can Save You Money

Linde engineers have been identified with the welding of many millions of feet of industrial piping and more than 20,000 miles of overland pipe lines. In this way Linde has accumulated a wealth of experience and understanding in the design and construction of piping systems. Over 100,000 Linde customers regularly benefit from this vast fund of knowledge, as developed and applied by Linde's research, development and field engineering facilities.

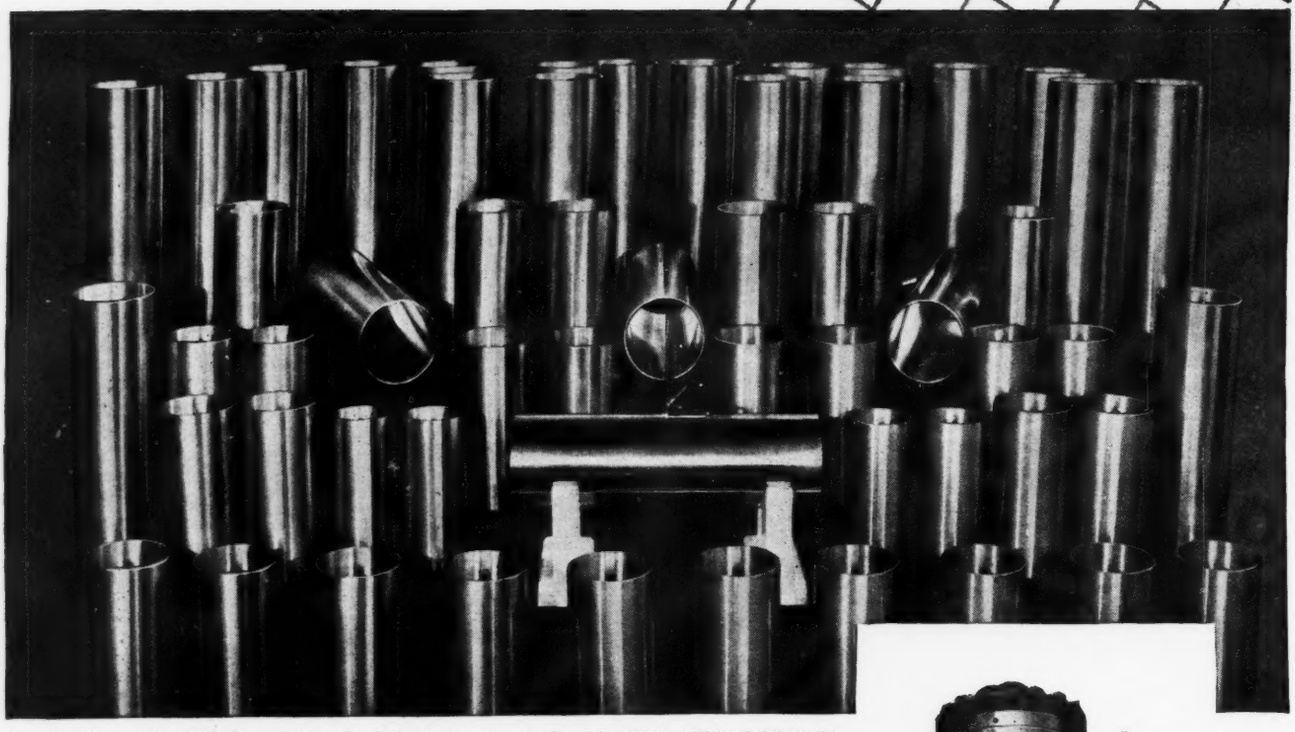
On your next piping project it will pay you to consult Linde. Communicate with the Linde Office nearest you or 30 East 42nd Street, New York, N. Y. Address: The Linde Air Products Company, Unit of Union Carbide and Carbon Corporation.

Everything for Oxy-Acetylene Welding and Cutting

LINDE OXYGEN • PREST-O-LITE ACETYLENE • OXWELD APPARATUS AND SUPPLIES FROM UCC LINDE UNION CARBIDE

These Pump Liners

WIN *with* NO SCORE



Centrifugally cast Monel Metal pump liners for boiler feed service, produced by SHENANGO-PENN MOLD CO., Dover, Ohio, for WARREN STEAM PUMP CO., Warren, Mass. Centrifugal casting insures dense and uniform structure. The choice of Monel Metal insures rust-proof smoothness, maximum wearing life of liner, protection of piston and piston packing. Insert at right: vertical single type pump made by Warren Steam Pump Co., equipped with centrifugally cast Monel Metal liners, and cold-drawn Monel Metal pump rods for boiler feed service both ashore and afloat.

. . . They beat wear, as well as rust and corrosion . . . they're centrifugally cast MONEL METAL

SCORING is important in the liner of a pump cylinder . . . important to KEEP OUT. And any pump-maker can tell you that with most liner metals it is very difficult to keep out.

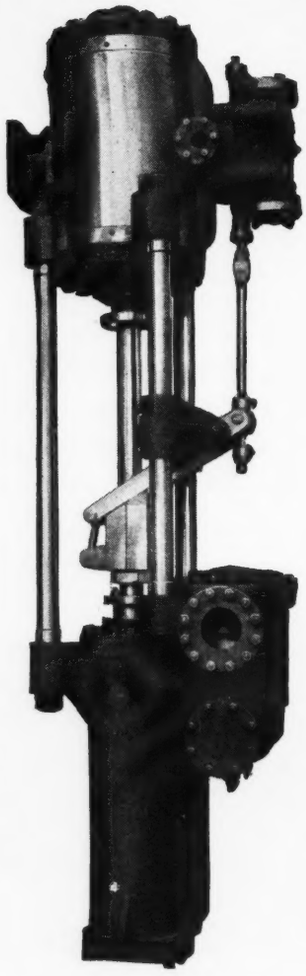
But makers of pumps and users of pumps alike learn by experience which metals do stay smooth in this hard service. And that's a big part of the reason Warren Steam Pump Co. specified Monel Metal for the pump liners shown here.

Monel Metal *does not rust*—not from fresh water or salt, from hot water or cold. A pump with this lining picks up no corrosion while it's off duty . . . it jumps back into the job full strength.

Since there's no pitting nor scoring, the inner surface holds a glass-smooth polish. Result: little or no wear on pistons and packing rings. Practically no leakage. And actual tests show that the hardness and density of structure you get from centrifugally cast Monel Metal make it outlast bronze or brass *from 3 to 10 times.*

It's not only in cylinder liners that Monel Metal helps this pump do its job. Water piston rods, steam valve stem, and water valve discs and springs are all made of this high-Nickel alloy.

You'll do well by your boiler pumps if you see that they have vital parts of Monel Metal. For answers to specific questions regarding pumps, consult Inco Engineers. Address:



THE INTERNATIONAL NICKEL CO., INC., 67 WALL ST., NEW YORK, N. Y.

Monel Metal is a registered trade-mark applied to an alloy containing approximately two-thirds Nickel and one-third copper. Monel Metal is mined, smelted, refined, rolled and marketed solely by International Nickel.

MONEL METAL

3 IMPORTANT NEW BOILER SAFETY DEVICES by RELIANCE DURING 1936

1

Reliance

E Y E – H Y E

Remote-Reading Water Gage

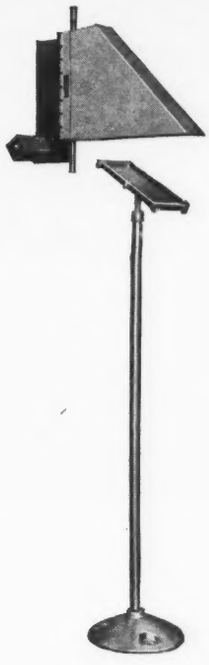
It brings an exact reading of your boiler water level right down to clear convenient eye height, anywhere you want it—on boiler or control board.

It shows the precise level of the water in the boiler as a bright green liquid, sharply illuminated.

It is accurate—and stays accurate. Months of stringent tests have proved it dependable and trouble-free.

If your water gages are high up on boilers, obscured by piping or structure, subject to frequent coating with dirt—if for any reason they're not quick and easy to see, EYE-HYE is what you've been looking for.

2



Reliance

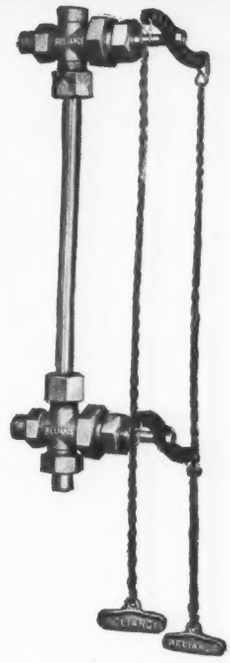
PERISCOPE

With a Reliance PERISCOPE you look at a clear reflection of the gage at eye height, in the mirror mounted on the floor stand. The mirror is adjustable so it does not have to be exactly in vertical line below the gage.

The metal hood on the gage has a high grade mirror mounted in the inclined front, which transmits the image to the floor stand mirror below. Special and efficient illumination is provided. Fits tubular glass, prismatic, flat glass or Micasight gages.

Installations of the Reliance PERISCOPE are permanent, trouble-free, easily cleaned—and moderate in cost.

3



Reliance Forged Steel

WATER GAGE

Valves for 2000 lbs. W.S.P.

These new forged steel valves are of the regrinding type, with fine new maintenance and service features.

Stem and seat of stainless steel; all parts in contact with liquid of stainless steel if desired. Seat is renewable, reversible and regrindable. Seat retaining nut removable with piece of square bar. Extra deep stuffing boxes on stem and glass connections, with high temperature super-seal packing. Buy these new Reliance Forged Steel valves with Micasight, Prismatic, flat or tubular glass—whichever your service requires—and your water gage troubles are over.

★ Reliance Engineering is meeting the new demands of industry for uninterrupted power and safety in the boiler room—at all pressures—by products typical of Reliance skillful design, patient careful testing, finest materials and manufacturing that builds all of the well-known Reliance dependability into them. Specify Reliance for safe uninterrupted power in 1937.

THE RELIANCE GAUGE COLUMN CO.

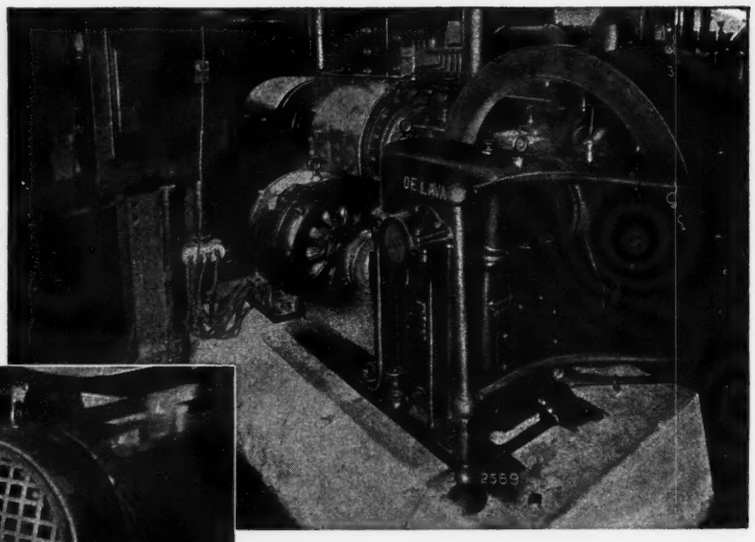
5924 CARNEGIE AVENUE, CLEVELAND, OHIO

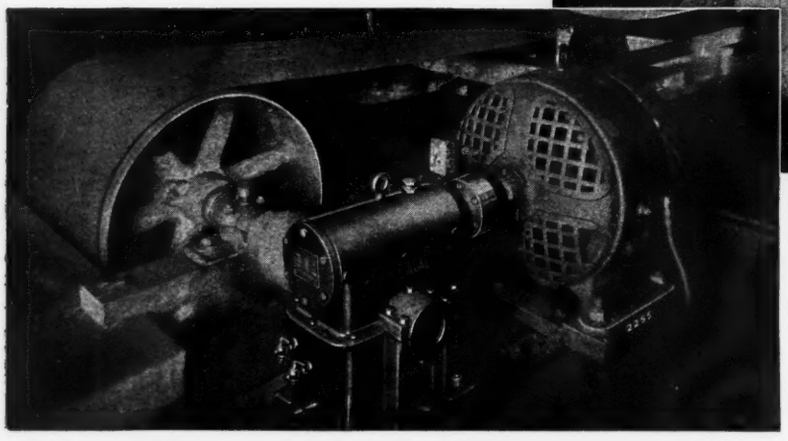
Reliance

TRADE MARK REG. U.S. PAT. OFF.

BOILER WATER LEVEL ALARMS AND INDICATORS

At Right—**The shock load encountered in driving a reciprocating vacuum pump** in a chemical plant (name upon request) has been carried by this 11-3/8 ratio De Laval worm gear **for nine years,** without renewal of or repair to any part. The motor delivers 40 hp. at 1160 r. p m.





At Left—**1,510,000 tons of wet coal** have been passed over this belt conveyor in the plant of the Potter Coal & Coke Co. during some **nine years,** but the 25 to 1 ratio De Laval worm gear through which the belt is driven has given no trouble and has required no repairs.

9 Years UNDER DIFFICULT CONDITIONS *Means Something*

THE ability to carry heavy loads continuously for long periods under severe conditions of shock, grit, moisture and scant attention means that *DE LAVAL WORM GEARS* are:

1—Correctly designed by engineers who have had extended experience with such gears,

2—Accurately manufactured by skilled men using suitable special tools, and

3—Made from the best of materials, carefully chosen and properly heat-treated.

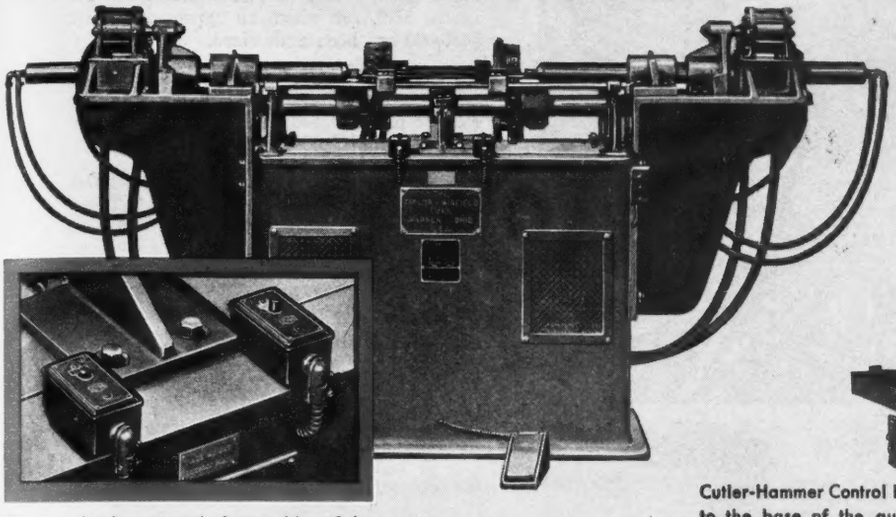
DE LAVAL WORM GEARS

solve many of the most troublesome problems in driving heavy machinery at slow and medium speeds from standard or high speed motors or steam turbines. Submit data of your requirements and we will gladly prepare recommendations and estimates.

4088

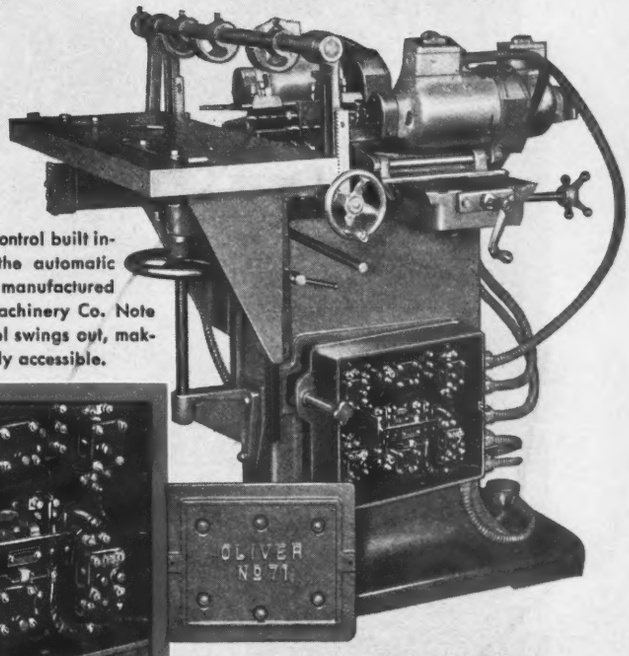
DE LAVAL STEAM TURBINE CO. TRENTON, N. J.

An ALL-REVEALING *Insignia*

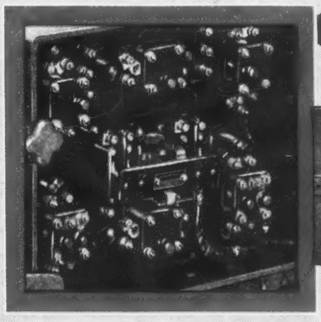


The completely automatic, butt welder of the Taylor-Winfield Corp., has its Cutler-Hammer Control in the base. Push-button stations may be located wherever desired, in this case convenient to the work.

CUTLER-HAMMER
MOTOR CONTROL
C-H

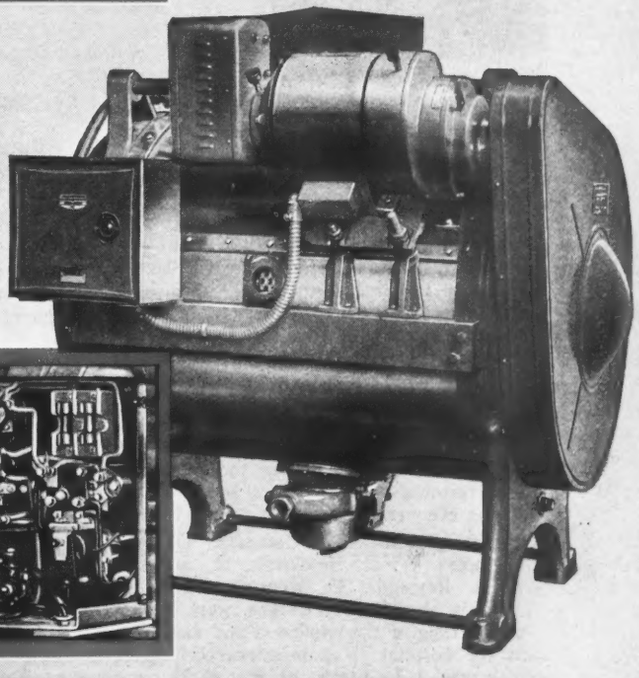


Cutler-Hammer Control built into the base of the automatic boring machine manufactured by the Oliver Machinery Co. Note how control panel swings out, making the rear easily accessible.

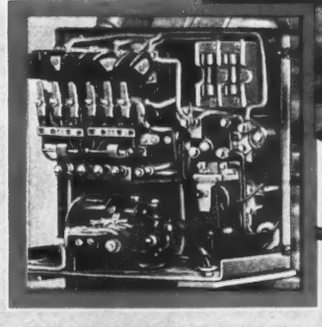


THAT a machine has "built-in" motor control tells many things. It is an indication of the modernness of the machine . . . that the machine is *completed*, ready to go . . . that it is provided with the control exactly fitting it. Built-in control helps to better appearance, makes for compactness, uniformity.

But, even more revealing . . . the Cutler-Hammer emblem on the built-in control. Insignia of the one name outstandingly associated with Motor Control, mark of the 43 years of Cutler-Hammer's unparalleled pioneering and success, it indicates that the machine maker has spared no effort to make his product the finest of its type. CUTLER-HAMMER, Inc., *Pioneer Manufacturers of Electric Control Apparatus*, 1358 St. Paul Ave., Milwaukee, Wis.

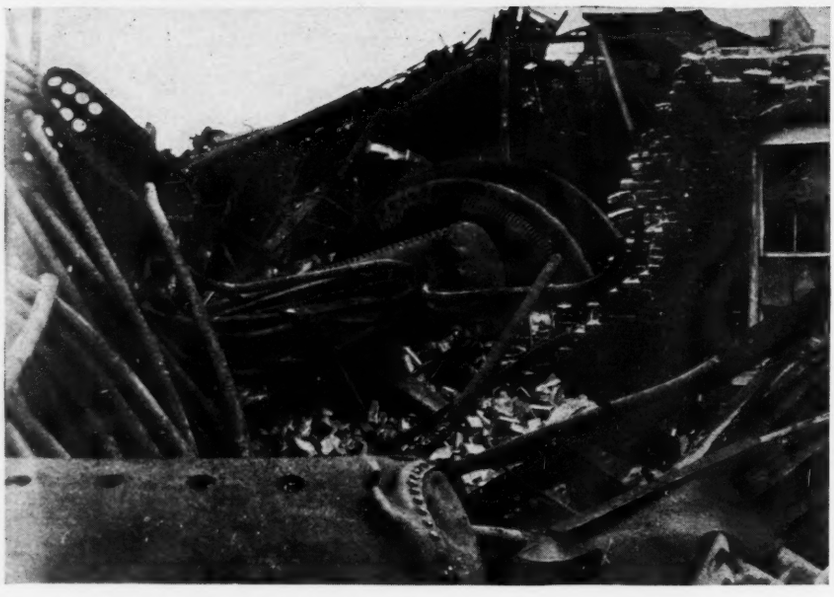


The Troy Laundry Machinery division of American Machine & Metals Mfg. Co. solved a difficult problem as shown. Accessibility of this C-H Control is featured.



CUTLER-HAMMER MOTOR CONTROL

STARTS ★ STOPS C-H REGULATES ★ PROTECTS



Two views of the wreckage at Moberly. Above, a general view of the plant; and below, a close-up of the wrecked boilers

MOBERLY BOILER EXPLOSION

It has been learned that the boiler explosion at the Moberly, Mo., Power Plant of Missouri Power & Light Co., Oct. 30, 1936, was caused apparently by the failure of the blind head of a Stirling boiler mud drum. The plant contained three such boilers in the main building and an additional boiler in an adjacent structure. The explosion demolished the main building and the equipment located therein. Electric service, which was interrupted by the explosion, was restored shortly before seven o'clock in the evening.

Four persons, Bert Bousman, 45, chief engineer; W. R. Brockman, 55, fireman; B. R. Reynolds, 35, fireman; and E. C. Perkins, shoe-factory worker, were injured at the time of the explosion and died later at the hospital from injuries received. A fifth man, J. D. Lewis, 19, was in the plant at the time of the explosion and was severely injured, but is now rapidly recovering.

RECENT STRAWS

BREMEN, IND., will soon place contracts for engine-generator units and auxiliary equipment for 2-story municipal power plant. Leroy Bradley, 221 West Wayne St., Fort Wayne, Ind., architect.

GLASGOW, KY., authorized bond issue of $200,000 at recent general election for municipal power plant, and will have plans soon.

MCCOOK, NEB., has plans for municipal power plant and distributing system to cost $340,260, of which 101,300 is represented by Federal grant. Begin work soon.

BAY CITY, MICH., has completed surveys and estimates for proposed municipal power plant with three turbo-generators and accessories, and distributing lines. Cost about $800,000. Ayres, Lewis, Norris & May, Ann Arbor, Mich., consulting engineers.

LOWELLVILLE, OHIO, will take bids soon for municipal power plant, including diesel unit. Fund of $50,000 authorized, Bryan & Sigman Engrg. Co., Newton Falls, Ohio, consulting engineer.

CABOOL, MO., plans municipal power plant and electrical distribution system with two 100-kw. diesel units and auxiliary equipment. Financing through Federal aid.

TREASURY DEPT., Washington, D. C., plans boiler plant in new multi-story post-office garage and service building at St. Louis, Mo., for which an appropriation of $430,000 has been authorized.

SHIRLEY H. COCHRAN, Prichard, Ala., and associates have plans under way for electric plant, including distributing system. Cost about $100,000. Franchise secured.

WILLIAMSTOWN, KY., has authorized bond issue of $72,000 for municipal power plant, and will proceed with project at early date. Bids will be asked for generator unit and accessory equipment.

DIXIE OIL REFINING CO., Detroit, Mich., recently organized by officials of Dixie Fuel & Supply Co., 301 South Cavalry St., Detroit, plans boiler plant at new refinery at Riverview, near Wyandotte, Mich., where 100 acres have been acquired. A pumping station and large steel tank storage division will be built. Entire project will cost $1,500,000. R. H. Montgomery and Paul R. Kemp are heads.

BENEKE CORP., 21st & Rockwell Sts., Chicago, Ill., contracted William Mavor Co., 7 South Dearborn St., for extensions and improvements in boiler house, including new boiler, fuel-handling and other equipment. C. M. Garland & Co., 38 South Dearborn St., consulting engineers. Cost close to $35,000.

FALLS CITY, NEB., plans addition to municipal power plant, with installation of new 1,200-hp. diesel unit and auxiliary equipment. Bids soon. Cost about $80,000.

LINCOLN, NEB., plans extensions in municipal plant. Surveys and estimates by Black & Veatch, 4706 Broadway, Kansas City, Mo., consulting engineers.

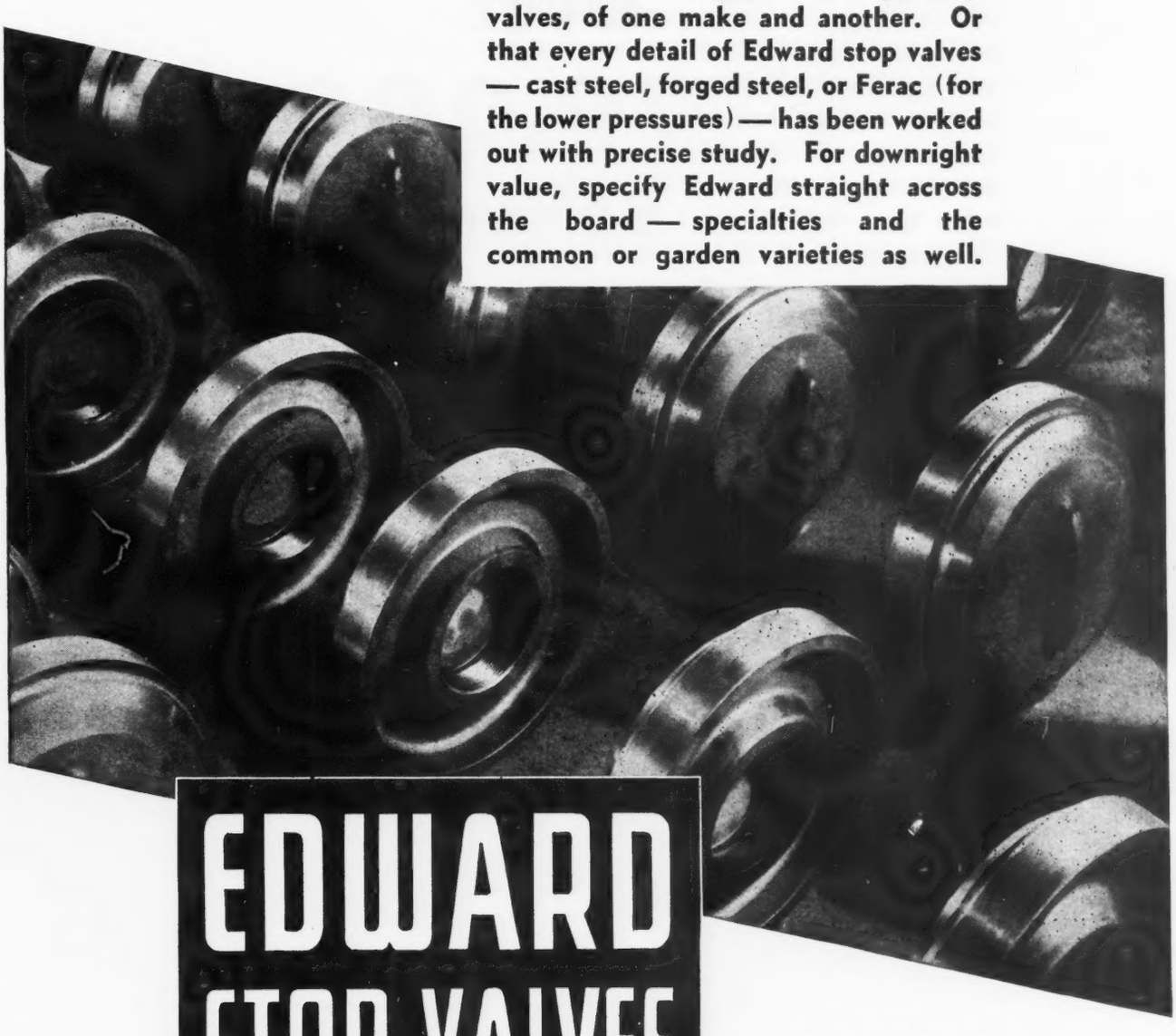
SCHOOL BOARD, Centerville, Ind., has plans for addition to steam power house for township school, to include two horizontal tubular boilers, two automatic stokers, pumping machinery and auxiliary equipment. C. E. Werking & Son, 200 East Main St., Richmond, Ind., architects.

WISCONSIN ICE & COAL CO., 1518 East North Ave., Milwaukee, Wis., contracted Vilter Mfg. Co., Milwaukee, for ice and refrigerating machinery for new plant unit at S. Forty-third & West Orchard Sts.; award for transformers and other power substation equipment to Milwaukee Electric Railway & Light Co., Milwaukee. Cost about $75,000.

SOUTHERN NEBRASKA NATURAL GAS CO., Holbrook, Neb., plans 6-in. welded steel pipeline from connection with present trunk line to Beaver City, Oxford, Neb., and neighboring communities, about 18 miles, for natural-gas transmission. Franchises have been secured and distribution systems will be installed. Entire project will cost close to $200,000.

POPLAR BLUFF, MO., will make extensions and improvements in municipal plant and waterworks. $40,000 has been secured through Federal aid. W. A. Fuller Co., 2916 Shenandoah Ave., St. Louis, consulting engineer.

NON-RETURN valves, blow-offs, and feed line stop-check valves — these are admittedly down the specialist's alley. And Edward's leadership in these lines is in the record. But not every buyer realizes how much difference there is between globe and angle stop valves, of one make and another. Or that every detail of Edward stop valves — cast steel, forged steel, or Ferac (for the lower pressures) — has been worked out with precise study. For downright value, specify Edward straight across the board — specialties and the common or garden varieties as well.



EDWARD pedigreed forged EValloy disks like these give plus value to EDWARD stop valves.

EDWARD STOP VALVES *Excel, too*

The Edward Valve & Manufacturing Co., Inc.

EAST CHICAGO INDIANA

High-Pressure Industrial Steam Plants

Data for Installations of 300 lb. Pressure and Above in the United States and Canada

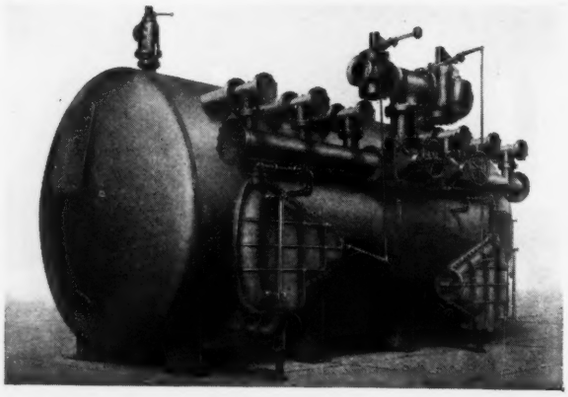
Compiled by F. A. Annett
Associate Editor

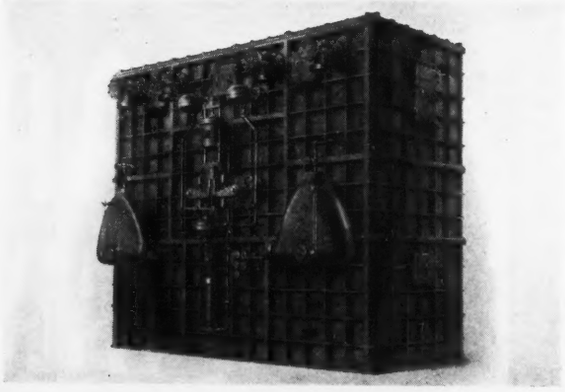
Company and Location	Kind of Industry	Initial Operation	No. of Boilers	Cap., Each, 1,000 Lb. per Hr.	Pressure, per Sq. In.	Temp. F.	Heating Surface, Sq. Ft.	Wall Surface, Sq. Ft.	Volume	Generated, Cu. Ft.	Ft.	Leaving F.	Per Sq. Ft.	Leaving Deg. F.	Pass. ller	D. Ft.
Pressures 700 Lb. and Above																
Philip Carey Mfg. Co., Lockland, O.	Heat Ins.															
Firestone Tire & Rubber Co., Akron, O.	Rubber															
Ford Motor Co., Dearborn, Mich.	Automobil															
Solvay Process Co., Syracuse, N. Y.	Chemica															
Goodyear Tire & Rubber Co., Akron, O.	Rubber															
Firestone Tire & Rubber Co., Los Angeles, Cal.	Rub															
Pressures 500 Lb. to 699 Lb.																
Champion Coated Paper Co., Hamilton, O.																
Humble Oil & Refining Co., Baytown, Tex																
Standard Oil Co. of N. J., Bayway, N. J.																
Standard Oil Co. of N. J., Canton, Md.																
Waldorf Paper Products Co., St. Paul, Minn.																
West Virginia Pulp & Paper Co., Piedmont, W. Va.																
West Virginia Pulp & Paper Co., Tyrone, Pa.																
West Virginia Pulp & Paper Co., Covington, Va.																
Anheuser Busch, Inc., St. Louis, Mo.																
Westinghouse Electric & Mfg. Co., Mansfield, O.																
Pressures 400 Lb. to 499 Lb.																
Advance Bag & Paper Co., Hodge, La.																
American Tobacco Co., Richmond, Va.																
American Tobacco Co., Reidsville, N. C.																
Anglo Canadian Pulp & Paper Co., Limoilou, Que																
Barber Asphalt Co., Madison, Ill.																
Blandin Paper Co., Grand Rapids, Minn.																
Bogalusa Paper Co., Bogalusa, La.																
Celanese Corp., Cumberland, Md.																
Champion Fibre Co., Canton, N. C																
Champion International Co., Lawrence, Mass.																
Chesapeake Corp., West Point, Va.																
Consolidated W. Pr. & Paper Co., Wis. Rapids.																
Phelps Dodge Corp., Bisbee, Ariz.																
Crocker Burbank Co., Fitchburg, Mass.																
Jacob E. Decker & Sons, Mason City, Ia																
DeLaval Steam Turbine Co., Trenton,																
Dow Chemical Co., Midland, Mich. (S.																
Du Pont Rayon Co., Richmond, Va.																
Du Pont Rayon Co., Waynesboro, Va																
E																
Fer																

Over 10,000,000 Boiler Horsepower is represented by the steam plants in the U. S. and abroad, protected by

COCHRANE

Engineering & Equipment





COCHRANE CORPORATION • 17th & Allegheny Ave. • Philadelphia, Pa.

COCHRANE

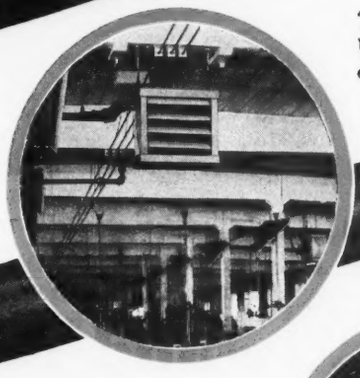
WATER SOFTENERS • DEAERATING HEATERS • FILTERS • BLOW-DOWN EQUIPMENT • VALVES • FLOW METERS

GRINNELL

WHENEVER PIPING IS INVOLVED

Automatic Sprinkler Fire Protection

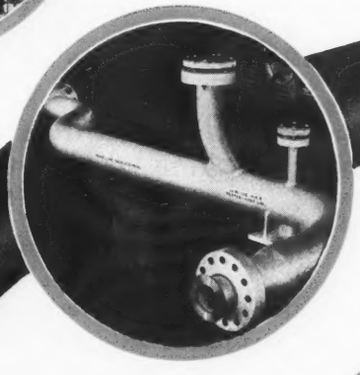
PLANT PROTECTION



Thermolier—The Grinnell Unit Heater with 14 Points of Superiority

HEATING

PLANT



PIPING

Pipe Fabrication and Welding Fittings

POWER AND PROCESS

Cast and Malleable Iron Fittings, Traps, Hangers, Valves, Plumbing and Heating Supplies

GENERAL PIPING

For Plant Construction, Modernization or Maintenance—look to Grinnell whenever the job involves piping.

Grinnell—a national organization with complete piping facilities "nearby" to every industrial plant.

GRINNELL COMPANY INC.

EXECUTIVE OFFICES PROVIDENCE, R. I.

Branch Offices in Principal Cities

DISTINCTIVE...

in design . . . and in service

Yes, the design is different from the old-type ring construction, or even the newer "V" packings. Note the shock-absorbing air space at the center of each ring.

See how the pressure on each ring forces the lips of the adjoining ring to the sides of the box, and to the rod. Automatic sealing is assured; gland pressure is unnecessary.

Just as the design is distinctive, so is the *service.* Free from trouble or costly maintenance, PAR Rings for high-temp, hot water or hydraulic service constitute the answer to many a packing problem. You'll be interested in the PAR circular; write for it.

Linear PAR 860—For Cold Water and Oil Hydraulics

Linear PAR 870—For Steam

Linear PAR 865—For Hot Water

Linear PAR 860-P—Perelin Binder for *Cold* Petroleum Products

Linear PAR 870-P—Perelin Binder for *Hot* Petroleum Products

LINEAR

PACKING & RUBBER CO., INC.

TACONY, PHILADELPHIA

"PAR" PACKINGS

Save Money with G-E Mechanical Drive Steam Turbines

These Multistage Turbines Give High Efficiency with Minimum Maintenance

BECAUSE—

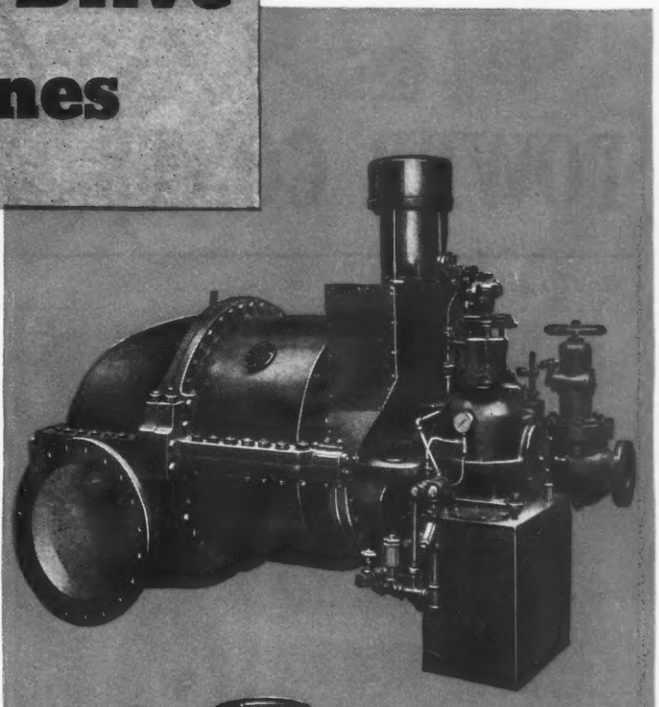
MULTISTAGING enables the turbine to transform into useful work the maximum amount of energy available in the steam.

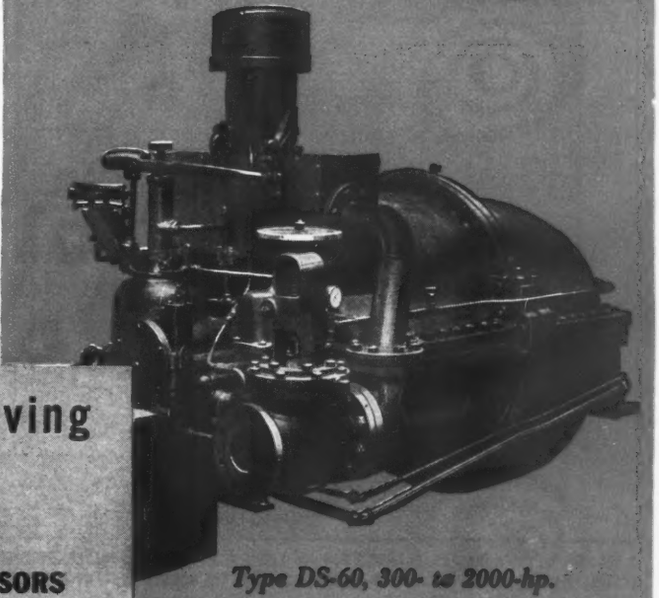
MIXED-PRESSURE OPERATION of these turbines makes it possible to obtain power from low-pressure steam heretofore not used. The steam is admitted to an intermediate stage and then passes through the last stages—this improves plant efficiency and reduces fuel cost.

EXTRACTION STEAM for process or heating is supplied from an intermediate stage of the turbine when the turbine is equipped with the extraction feature. As no internal lubrication is used, the extracted steam is clean—and a clean heating system saves fuel.

LOW COSTS for repairs and replacements result from the use of few moving parts. A completely enclosed and well-designed lubrication system keeps wear at the minimum. Careful design and manufacture give you a turbine which will stand up under the most exacting service.

There is a G-E turbine for your requirements, in any size and horsepower rating. Let the nearest G-E turbine specialist help you choose turbines; or, call the nearest G-E sales office for information. If you do not have literature further describing our mechanical-drive turbines, write us for it. General Electric, Schenectady, New York.





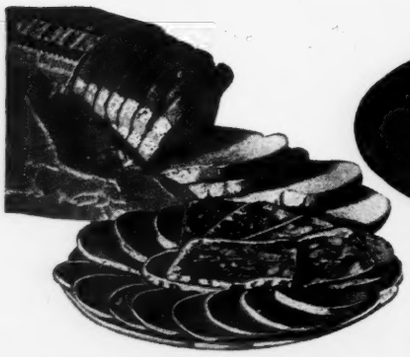
Type DS-60, 300- to 2000-hp.

720-238

For Driving

- PUMPS
- FANS
- COMPRESSORS
- BLOWERS
- LINE SHAFTS
- PULVERIZERS

GENERAL ELECTRIC

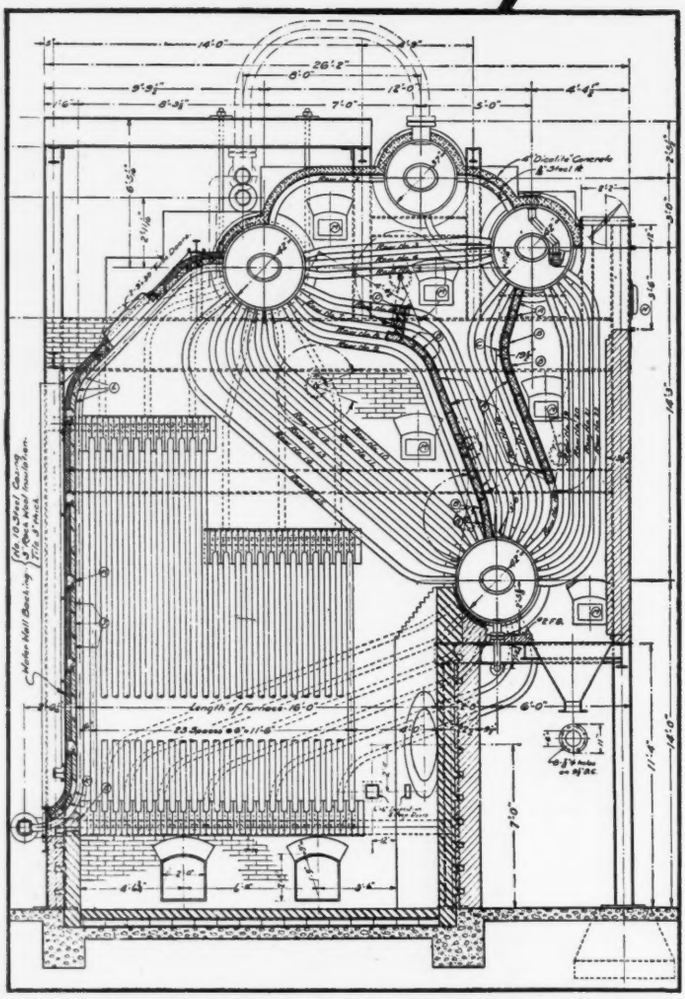


KROGER
Grocery and Baking Company
CINCINNATI

keeps

POWER COSTS *and* FOOD PRICES

DOWN



2-528 HORSE POWER BOILERS, DESIGNED FOR 400 LBS. S.W.P. AND USING PULVERIZED FUEL, AS INSTALLED IN CINCINNATI BAKING AND PACKING PLANT OF THE KROGER GROCERY & BAKING CO.

FOSDICK & HILMER, CONSULTING ENGINEERS
CINCINNATI, OHIO

Sound merchandising of quality foods at lowest prices makes imperative the scrutiny of every processing cost.

Steam power cost is an important item in any industry and alert management insists on equipment that will produce the most steam at the least expense.

KROGERS, known for better foods at lower prices, find Vogt boilers a distinct aid in keeping overhead to a minimum.

VOGT BOILERS will do as much for you.

HENRY VOGT MACHINE CO.
INCORPORATED

Louisville, Kentucky

Manufacturers of: Water Tube Boilers, Drop Forged Steel Valves and Fittings, Oil Refinery Equipment, Ice Making and Refrigerating Machinery, Heat Exchangers.

Vogt WATER TUBE BOILERS

BRANCHES: NEW YORK · DALLAS · CHICAGO · CLEVELAND · KANSAS CITY · PHILADELPHIA · CINCINNATI

the difference is FLEXIBILITY

Select the Rope that Fits Your Job

There is always the temptation when selecting wire rope to choose the one with fewer but heavier outer wires to gain longer life through better resistance to external abrasion. This is often an error especially when sheaves are small and loads light. Rope with fewer outerwires is stiffer. A rope without sufficient flexibility for its purpose will bulge away from the sheave thus reduce contact area and permit the rope to slide. The resulting increased wear defeats the objective of the selection. Every sheave and load requires a rope with a definite degree of flexibility. Tell us your conditions and we will gladly recommend a rope construction that will give the longest possible life.

WICKWIRE SPENCER STEEL COMPANY, *General Offices:* 41 East 42nd Street, New York. *Sales Offices and Warehouses:* Worcester, New York, Chicago, Buffalo, San Francisco, Los Angeles; *Export Sales Dept.:* New York. WICKWIRE SPENCER SALES CORPORATION, New York, Chattanooga, Tulsa, Portland, Seattle.

WIRE ROPE
by Wickwire Spencer

WICKWIRE SPENCER STEEL CO.
41 East 42nd St., New York City
Please send me your new Rope Manual that tells how to make wire rope last longer.

Name_____

Firm_____

Address_____

City_____ State_____

Orders keep rolling in for

FULLER ROTARY COMPRESSORS

WE point with pardonable pride to the many orders being received for Fuller Rotary Compressors and Vacuum Pumps, and to installations made recently.

Illustrated on the right, reading from top to bottom: Two-stage Compressor at a mid-west incinerator plant, (one of three compressors installed) . . . Single-stage Vacuum Pumps in a Pacific Coast glass manufacturing plant . . . Single-stage Compressor in a western public utility . . . Single-stage Vacuum Pump, for new special process used in rapid drying and hardening of concrete.

Some of the important features that contribute to this popularity, and which you should certainly consider when purchasing air compressors, are:

NO AIR-LINE PULSATIONS
SIMPLE CONSTRUCTION
NO BEARING TAKE-UP
SMALL FLOOR SPACE
LOW MAINTENANCE
NO VIBRATION
DIRECT DRIVE
LIGHT WEIGHT
LONG LIFE

FULLER COMPANY
CATASAUQUA, PENNSYLVANIA

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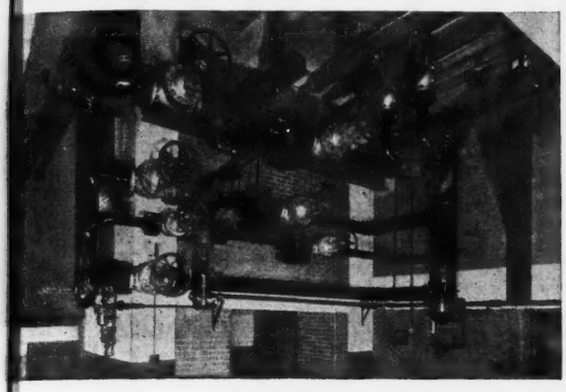
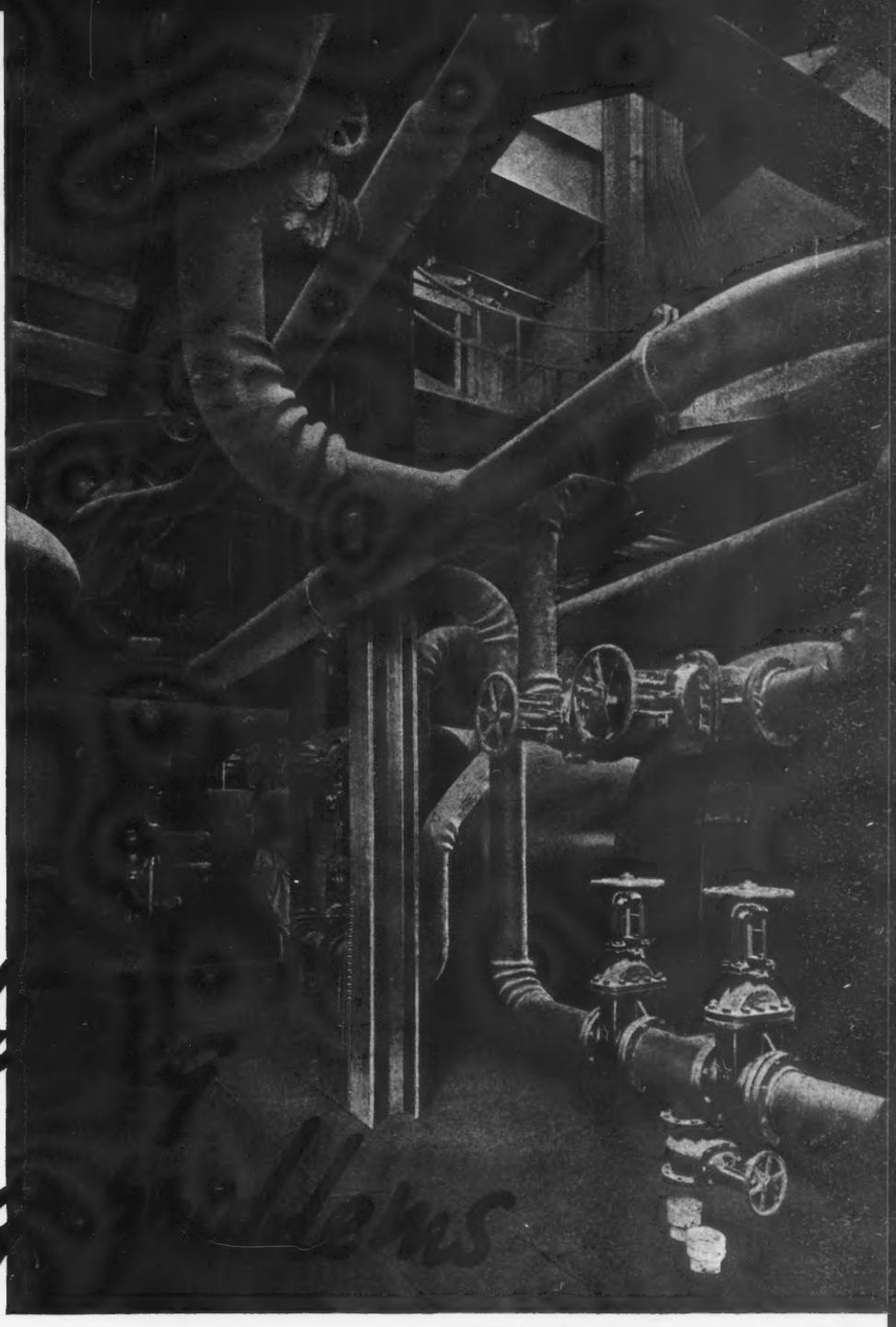
C-11

FULLER-KINYON, FLUXO, AND AIRVEYOR CONVEYING SYSTEMS · · · ROTARY FEEDERS AND DISCHARGE GATES
ROTARY AIR COMPRESSORS AND VACUUM PUMPS · · AUTOMATIC BATCH WEIGHERS · · · BIN SIGNALS



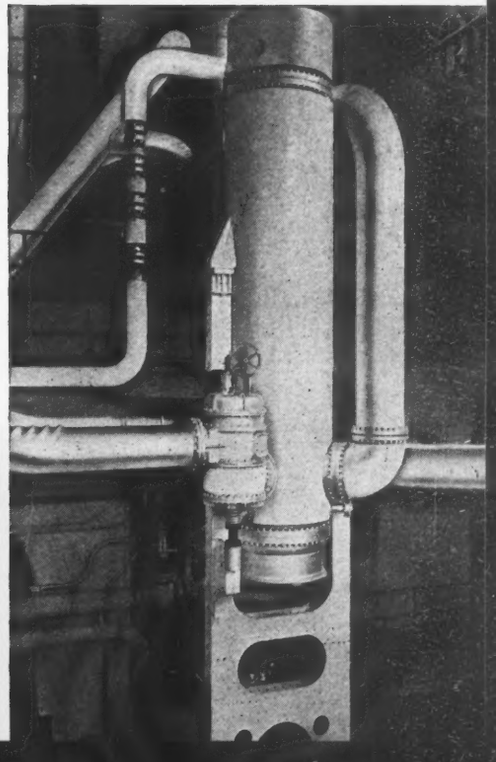


Specialists on piping

FROM POWER TO PROCESS

Thirty-three years in the business have brought this company into intimate contact with every variety of piping installation. This accumulated experience permits **Pittsburgh Piping** to offer exceptional design, fabrication and installation service in any and every piping application, from power to process. Inquiries are invited.

PITTSBURGH PIPING AND EQUIPMENT COMPANY
43rd STREET and A. V. R. R. PITTSBURGH, PA.



Pittsburgh Piping

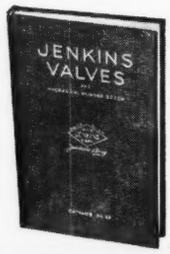
Whether you need
a 2″ or a 48″ GATE

—or any size in between—
you will find sound reasons
for buying a "Jenkins"...

CRITICAL examination of any Jenkins Iron Body Gate Valve reveals the benefits of Jenkins skilled craftsmanship and 70 years of specialization in the manufacture of fine valves. In every size and type are found superiorities of design and construction which provide for exceptional valve service.

Strength is emphasized in making Jenkins Iron Body Gate Valves. Out of the eighteen superior features found in a "Jenkins", nine are strength-multiplying points. From stuffing box bolts to body, a Jenkins Gate is made capable of handling ordinary duty with an ease that means longer valve life, and less maintenance work and expense. Because of this great reserve strength, it can also "carry-on", even if extraordinary strains should be encountered.

In the Jenkins Catalog you will find Iron Body Gate Valves for most any need. Sizes from 2″ to 48″, in Solid Wedge and Double Disc Parallel Seat types, and operated by motor, cylinder or special gearing arrangements.



JENKINS BROS., 80 White Street, New York, N.Y.; 510 Main Street, Bridgeport, Conn.; 524 Atlantic Ave., Boston, Mass.; 133 N. Seventh Street, Philadelphia, Pa.; 822 Washington Blvd., Chicago, Ill.; JENKINS BROS., Ltd., Montreal, Canada; London, England.

Jenkins Valves

BRONZE—IRON—STEEL SINCE 1864

Condor Compensated

TRADE MARK REGISTERED

PATENTED

Condor Compensated Belt on a main drive. Note low tension sag.

Condor Compensated Belt on a spinning room drive.

THE LOW TENSION RUBBER BELT

With Equalized Ply Stresses

In the construction of Condor Compensated Belt new engineering principles are utilized: the belt is made to conform to the pulley curvature. Instead of the outside plies bearing an overload and rupturing, *all* the plies share equally in bearing the stresses which are developed at the arc of contact, when the belt is flexed around the pulleys under high tension. In addition, the belt has a special pulley surface which permits the belt to be run at much lower tension than other belts. Results: longer belt life and freedom from mechanical troubles, with other advantages listed here. And the net result of all these advantages to you is: *Lower Power Transmission Costs.*

12 ADVANTAGES

1. Ruptures in outside ply practically eliminated
2. Ply separation practically eliminated
3. Longer fastener life
4. Operation less affected by atmospheric conditions
5. Less bearing, shafting and hanger troubles
6. High efficiency
7. Higher overload capacity or margin of safety
8. Less wear on pulley side
9. Can be operated on smaller pulleys
10. For heavy loads, plies may be increased with same pulleys
11. Can be dressed without destructive effect
12. Material reduction in belting costs

Condor PRODUCTS

Transmission Belt
V-Belt
Conveyor Belt
Air Hose
Contractors Hose
Sand Blast Hose
Suction Hose
Fire Hose
Hydraulic Hose
Steam Hose
Water Hose

Chute Lining
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Industrial Brake Blocks and Lining
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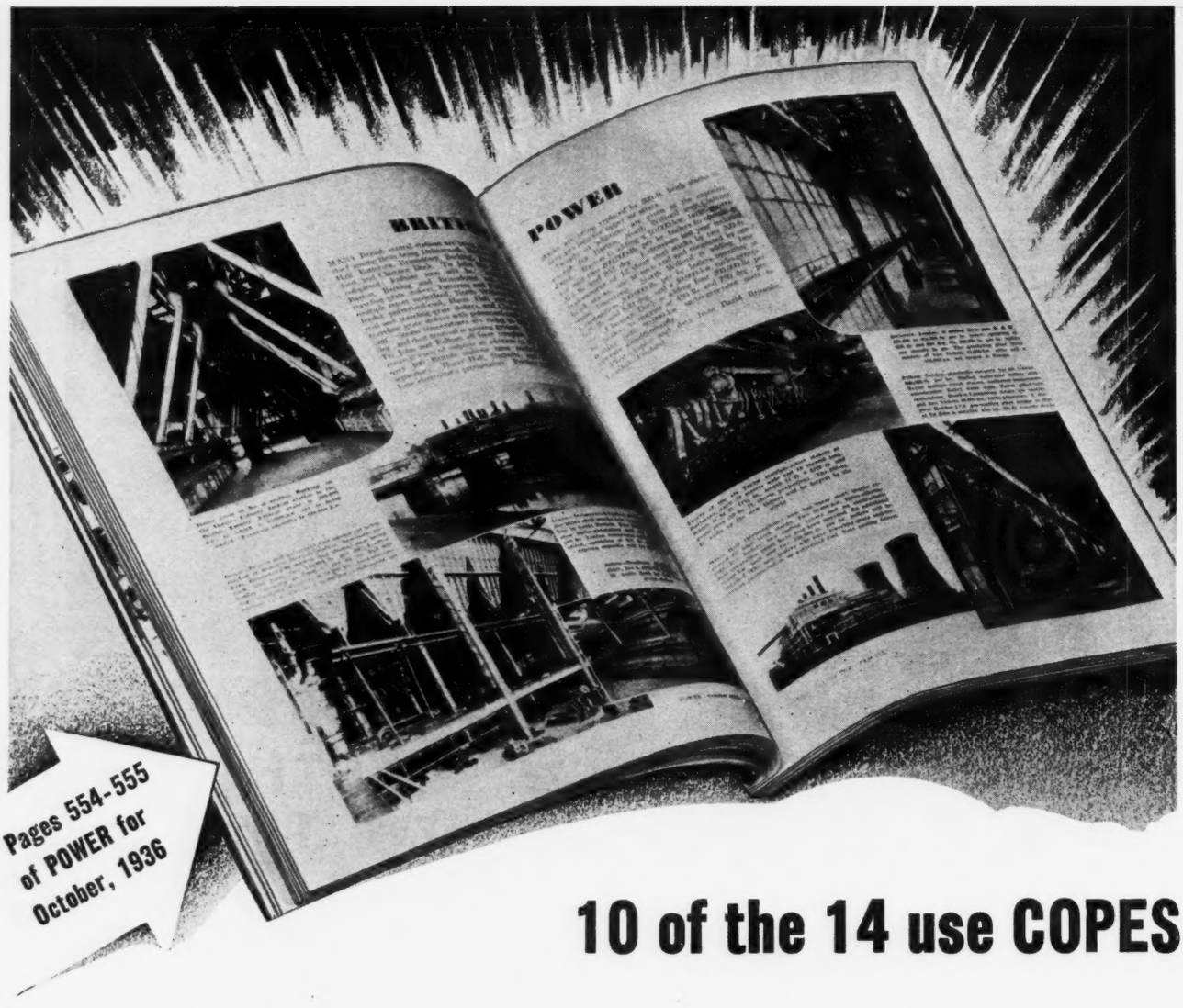
Write for new General Catalog

Sold by leading jobbers

THE MANHATTAN RUBBER MFG. DIVISION

OF RAYBESTOS-MANHATTAN, INC.

EXECUTIVE OFFICES and FACTORIES, 31 TOWNSEND ST., PASSAIC, N. J.



10 of the 14 use COPES

British power stations depend on COPES for effective, economical boiler feed control. In the British Isles, there are 127 COPES equipped boilers operating in the pressure range from 400 to 1575 pounds . . . with evaporation rates as high as 300,000 pounds per hour.

And of the 14 modern plants discussed in the article reproduced above . . . the "show plants" of Great Britain . . . these 10 use COPES Feed Water Regulators:

Barking	Dalmarnock
Battersea	Dunston
Bradford	Fulham
Brimsdown	Hams Hall
Clarence Dock	North Wilford

Throughout Great Britain . . . as in America . . . COPES Feed Water Regulators are the accepted standard. Rugged . . . dependable . . . effective in actual service. COPES definitely improves boiler operation. Ask any user. You'll find one near you. May we tell you where?

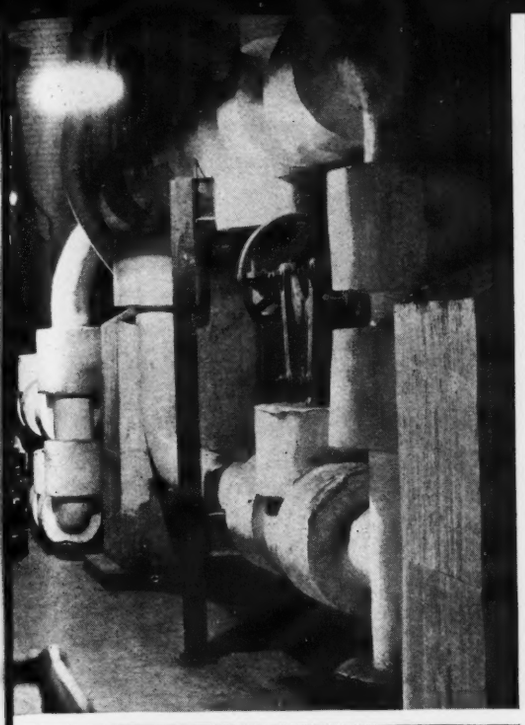
NORTHERN EQUIPMENT CO., 1221 GROVE DRIVE, ERIE, PA.

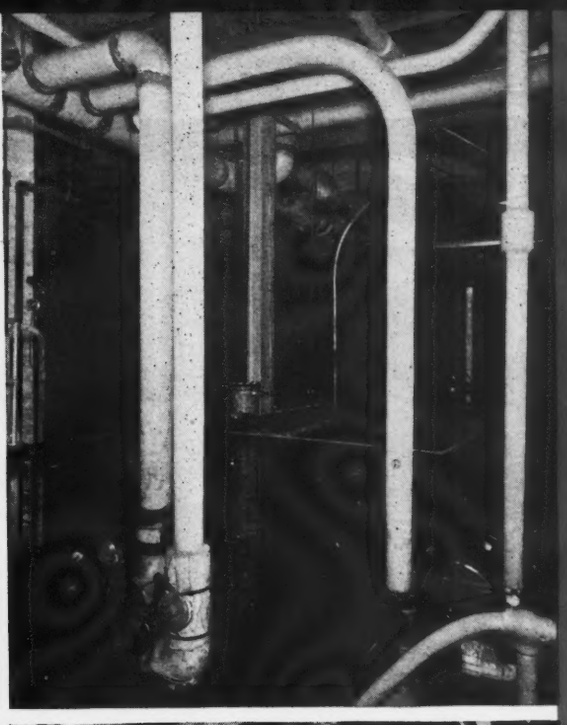
FEED WATER REGULATORS - DIFFERENTIAL VALVES - PUMP GOVERNORS - CONDENSATE DRAINAGE AND LIQUID LEVEL CONTROLS - BALANCED FLOAT, MOTOR, THRUSTOR AND PRESSURE REDUCING VALVES

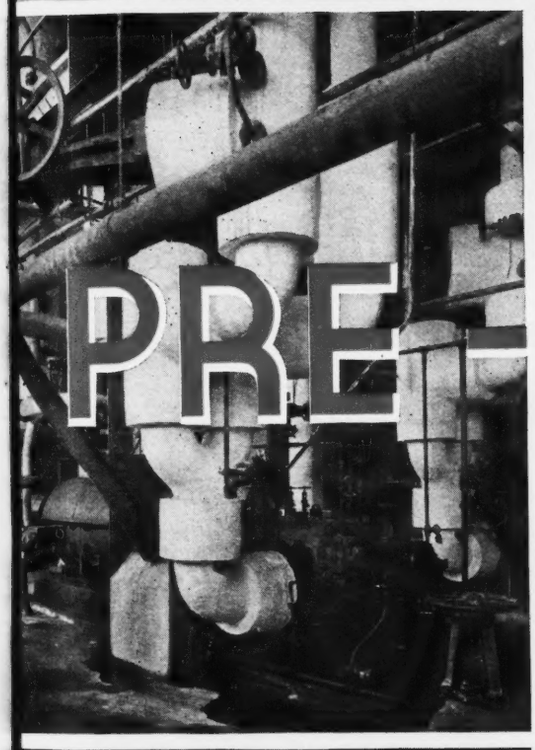
COPES

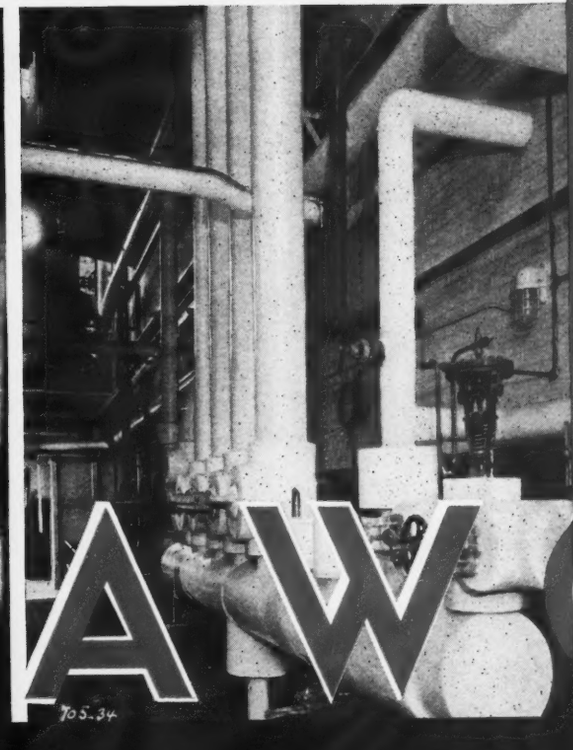
SYSTEM OF BOILER FEED CONTROL

BRANCH PLANTS IN CANADA - ENGLAND - FRANCE - GERMANY - AUSTRIA - ITALY - SALES AND SERVICE REPRESENTATIVES IN PRINCIPAL INDUSTRIAL CENTERS THROUGHOUT THE WORLD







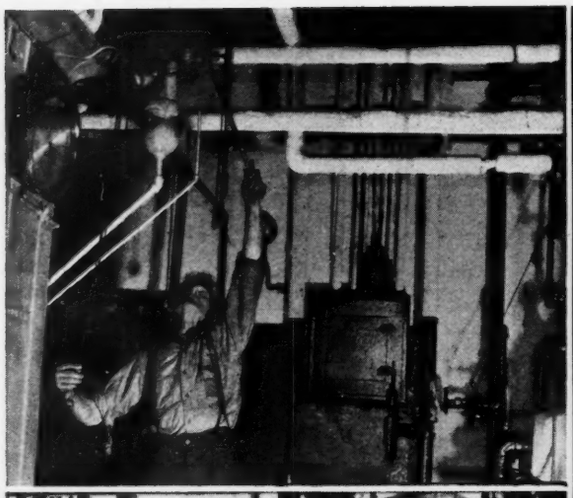


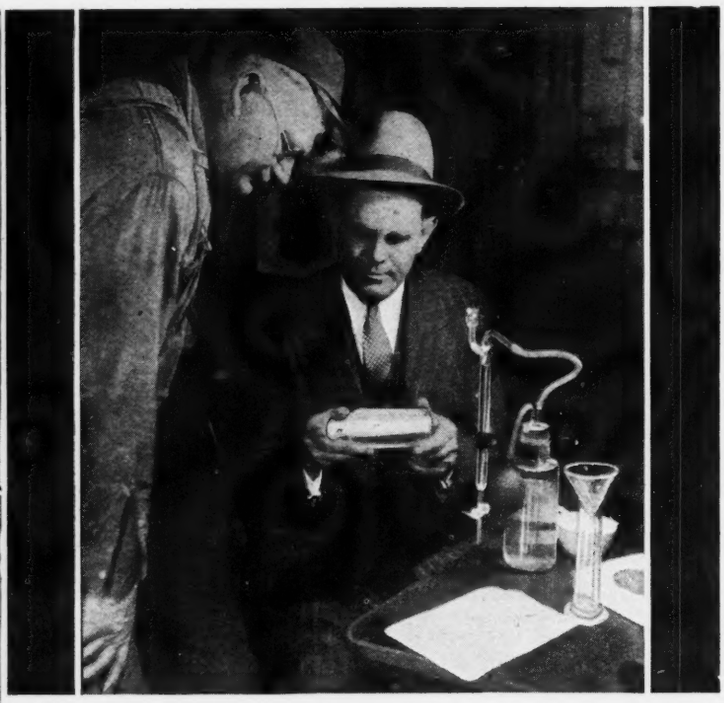
A to Z in Pipe PRE-fabrication

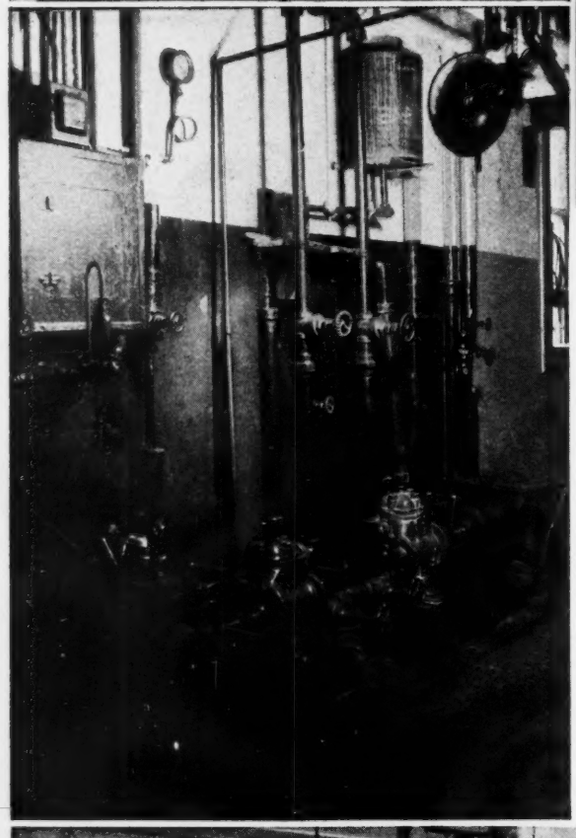
From the preliminary estimating, engineering and drafting of one header or a complete piping system, to the final testing and erection, Shawco is adequately equipped in both experience and facilities. Every operation in the pre-fabrication of piping, whether it be welding, bending, flanging, heat-treating, threading, machining, grinding or forging, is performed in our own shops and by our own men. Quality and economy are thus definite, foregone conclusions. The photographs show some typical Shawco jobs and if you would be interested, we'll gladly send you a comprehensive list of concerns that know the satisfaction of "Shawco Pre-fabrication." The Benjamin F. Shaw Co., 503 East Second Street, Wilmington, Del.

SHAWCO

705.34







"See that test? Zero hardness. Dearborn fixed us up. Our trouble was scaled tubes. They examined our plant and analyzed the water; then furnished treating materials and scheduled our blow downs. Now we have no more scale."

Dearborn
TRADE MARK REGISTERED

INDIVIDUALIZED FEED WATER TREATMENT WITH DEARBORN LABORATORY AND PLANT CONTROL SERVICE

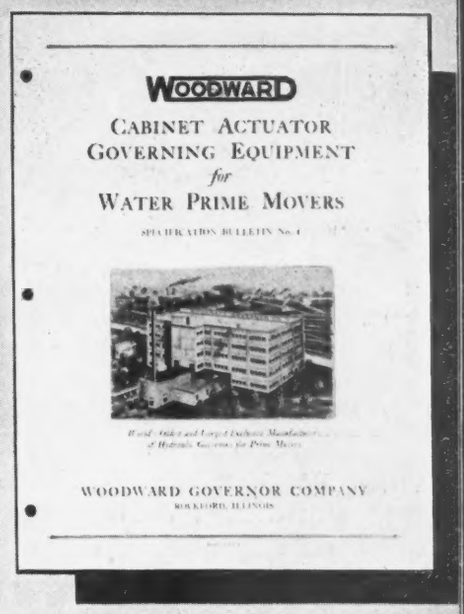
DEARBORN CHEMICAL COMPANY

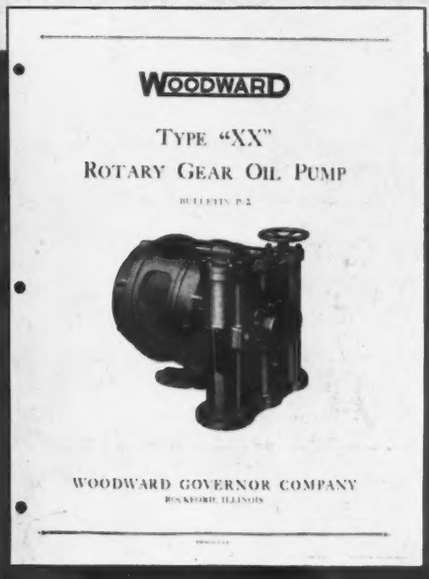
310 S. Michigan Ave. CHICAGO
205 E. 42nd St. NEW YORK
2454 Dundas St. W TORONTO

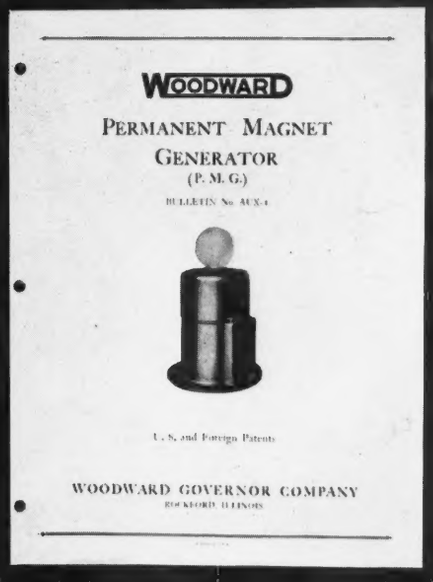
THESE 4 DATA BULLETINS

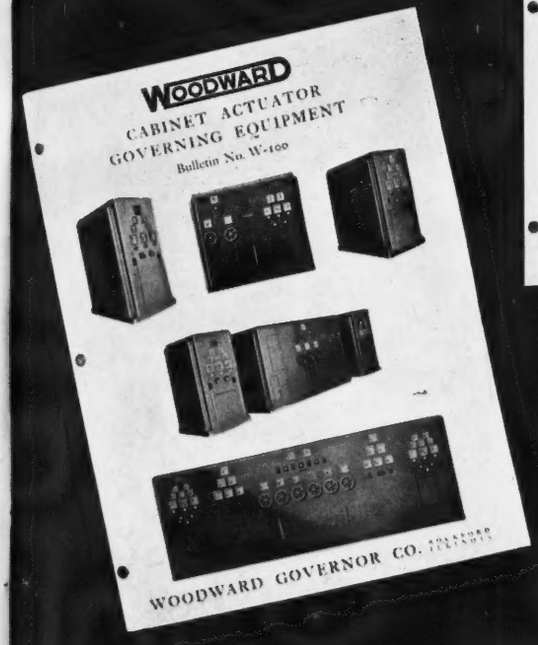
are dedicated to ---

FINER REGULATION
HARMONIOUS DESIGN
EASE of OPERATION
PLANT EFFICIENCY









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WOODWARD

WOODWARD CABINET ACTUATOR GOVERNING EQUIPMENT FOR WATER PRIME MOVERS

A 28-page engineering manual containing a discussion of fundamental principles of governing; instructions for making preliminary calculations and description of both "Unit" and "Twin System" types of Cabinet Actuator Governing Equipment. Typical plant layout and arrangement drawings and sample specifications for actuator governing equipment are included.

WOODWARD

WOODWARD CABINET ACTUATOR GOVERNING EQUIPMENT

A complete operating manual giving detailed instruction for the installation and operation of Cabinet Actuator Governing Equipment. Sectional views show typical construction of "Unit" and "Twin System" types, pressure tanks, restoring connections, etc., while 15 cuts and 25 half tone plates illustrate the detailed explanation.

WOODWARD

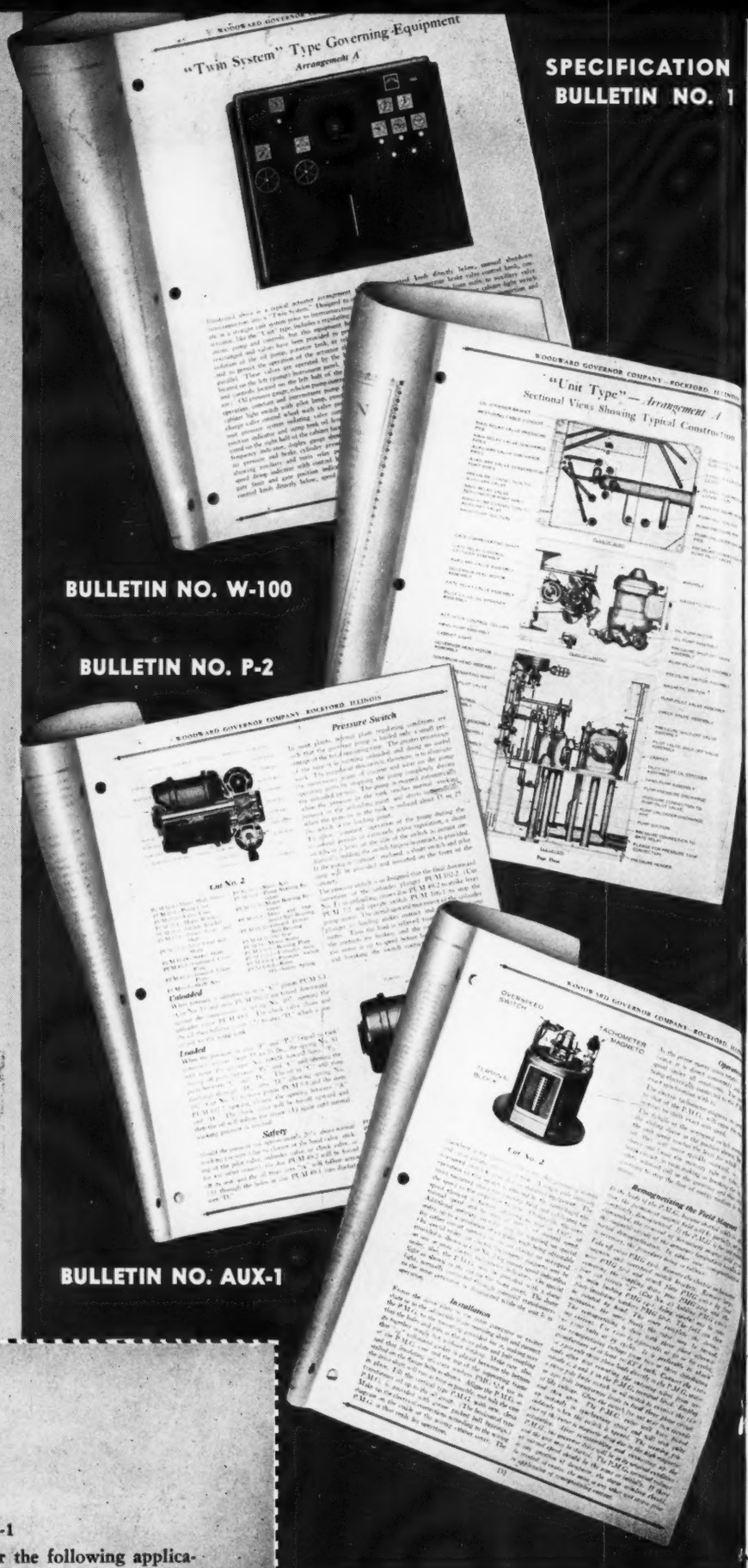
WOODWARD TYPE "XX" ROTARY GEAR OIL PUMP

This bulletin fully describes the installation, construction and operation of the Type "XX" oil pump used in Cabinet Actuator Governing Equipment and explains the action of the Woodward Pressure Switch and Echelon Control. Pump outlines and dimensions are included.

WOODWARD

PERMANENT MAGNET GENERATOR (P.M.G.)

This bulletin is a practical treatise on the construction and operation of the Permanent Magnet Generator with cuts showing typical applications. A Permanent Magnet Generator, direct connected to the prime mover, used in conjunction with a synchronous motor direct connected to the governor head of the regulating mechanism, affords the best method yet devised for rotating the governor head in unison with the prime mover.



SPECIFICATION BULLETIN NO. 1

BULLETIN NO. W-100

BULLETIN NO. P-2

BULLETIN NO. AUX-1

WOODWARD GOVERNOR COMPANY
ROCKFORD, ILL.

Gentlemen:

Please send me the following bulletins:—

☐ Spec. Bulletin No. 1 ☐ Bulletin No. P-2

☐ Bulletin No. W-100 ☐ Bulletin No. AUX-1

also information on WOODWARD Governing Equipment for the following applications:

☐ Steam ☐ Internal Combustion

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WOODWARD

Prime Mover Control

★ STEAM

★ WATER POWER

★ INTERNAL COMBUSTION

STOP WASTE IN INDUSTRY WITH Quigley Products

HYTEMPITE

STOP the early breakdown of fire brick joints by the use of HYTEMPITE—The World's Standard High Temperature Cement.

FYRE-MORTAR

STOP the wasteful use of fire clay for troweled joints—use FYRE-MORTAR, the superior dry high temperature mortar.

Q-CHROME

STOP slag action on brick joints with Q-CHROME neutral base refractory cement.

Q-CHROMASTIC

STOP erosion, spalling and failure of brickwork, with Q-CHROMASTIC, plastic, super-refractory coating.

HEARTH-CRETE

STOP using refractories that fail, replace with HEARTH-CRETE, the chrome-magnesite castable refractory to replace chrome, magnesite, silicon carbide, silica and fire-clay refractories.

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JOINT SEALING COMPOUND

STOP leaky steam joints and corroding connections with Q-SEAL, plastic, expansive, joint sealing compound.

CAST-REFRACT

STOP waiting for special shapes. Use CAST-REFRACT to mold them on the job and light furnace tomorrow.

MONO-LINE

STOP air leakage by omitting joints. Use MONO-LINE highest quality fire brick in plastic form for monolithic construction.

ACID PROOF CEMENT

STOP using weak materials for acid towers, tanks, and stacks. Use **QUIGLEY** ACID PROOF CEMENT that stands the acid test.

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STOP using brick for wrong applications. Use **QUIGLEY** FIRE BRICK specially made for your needs in Missouri, Pennsylvania, and New Jersey brands.

QUIGLEY REFRACTORY GUN

STOP losing time on repairs; use the **QUIGLEY** REFRACTORY GUN for speedy and permanent repairs of side walls, bridge walls, baffles, flues and chambers.

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PROTECTIVE COATINGS

STOP corrosion losses; use TRIPLE-A Protective Coatings on all steelwork exposed to moisture, corrosive fumes, heat, etc.

ANNITE

DETERGENTS

STOP using inefficient soaps and powders for cleaning operations; use *ANNITE* detergent cleaning materials. "Gentle as a Lamb—Strong as a Lion."

DAMIT

WATERPROOF JOINT SEALING COMPOUND

STOP hot or cold water leaks with DAMIT—"It dams the leaks."

INSULBRIX

STOP heat storage and other losses with INSULBRIX, lightweight, cellular, insulating refractory for direct or indirect flame exposure.

INSULCRETE

STOP absorbing heat into wall structures by the use of INSULCRETE, the insulating refractory castable for shapes and concrete.

INSULBLOX

STOP making thick fire brick walls. Use INSULBLOX, insulating refractory (2200° F.) of high mechanical strength in block form for low heat storage fire brick walls.

INSULINE

STOP using low service temperature insulating powders and aggregates. Use INSULINE powdered, with thin wall next to fire speed kiln and furnace operations and lower production costs. Or, use INSULINE **Sized Aggregate** also as fill or for making insulating refractory concrete.

INSULAG

STOP using lagging that shrinks and lowers insulating value. Use INSULAG for outside of breechings, pipes, stills, fractionating towers, boilers—high mechanical strength, long life, no shrinkage, "the lagging that sticks and stays".

INSULCLAD

STOP gas penetration and dusting in insulating refractories—use INSULCLAD for coating (2300° F. to 3200° F.).

For further information write **QUIGLEY COMPANY** INC. *56 West 45th Street*
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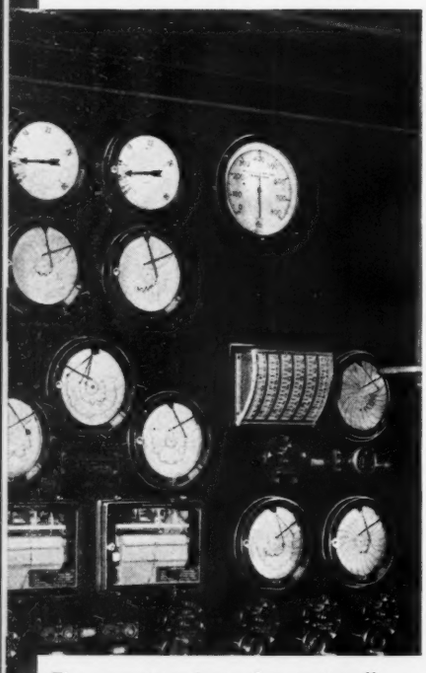
Makers of **HYTEMPITE** *"The World's Standard High Temperature Cement"*

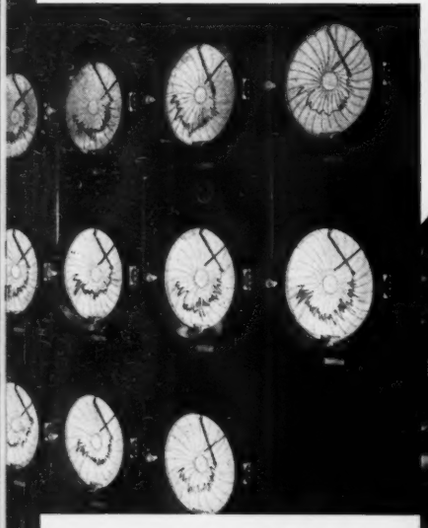
Distributors with Stocks and Service in Important Industrial Centers throughout the United States, Canada, and in 32 other countries.

WHEN YOU'RE LOOKING

A central heating plant furnishing steam to buildings covering seven square blocks reduced fuel costs 23% with the aid of Brown Instruments.



The superintendent of a nationally known sugar refinery credits the above Brown Instruments in the boiler room for checking steam distribution with saving 1,000,000 lbs. per month. This is a gross saving of $6000 a year.



The new power plant of the Theodore Hamm Brewing Company burns approximately 2500 tons of coal per year less than the old plant.

Mr. W. H. Lang, Supt., says:

"The installation of Brown Instruments in our power plant is very satisfactory. We feel that probably the best proof of this is the fact that we have ordered several additional instruments for applications in other parts of the plant."

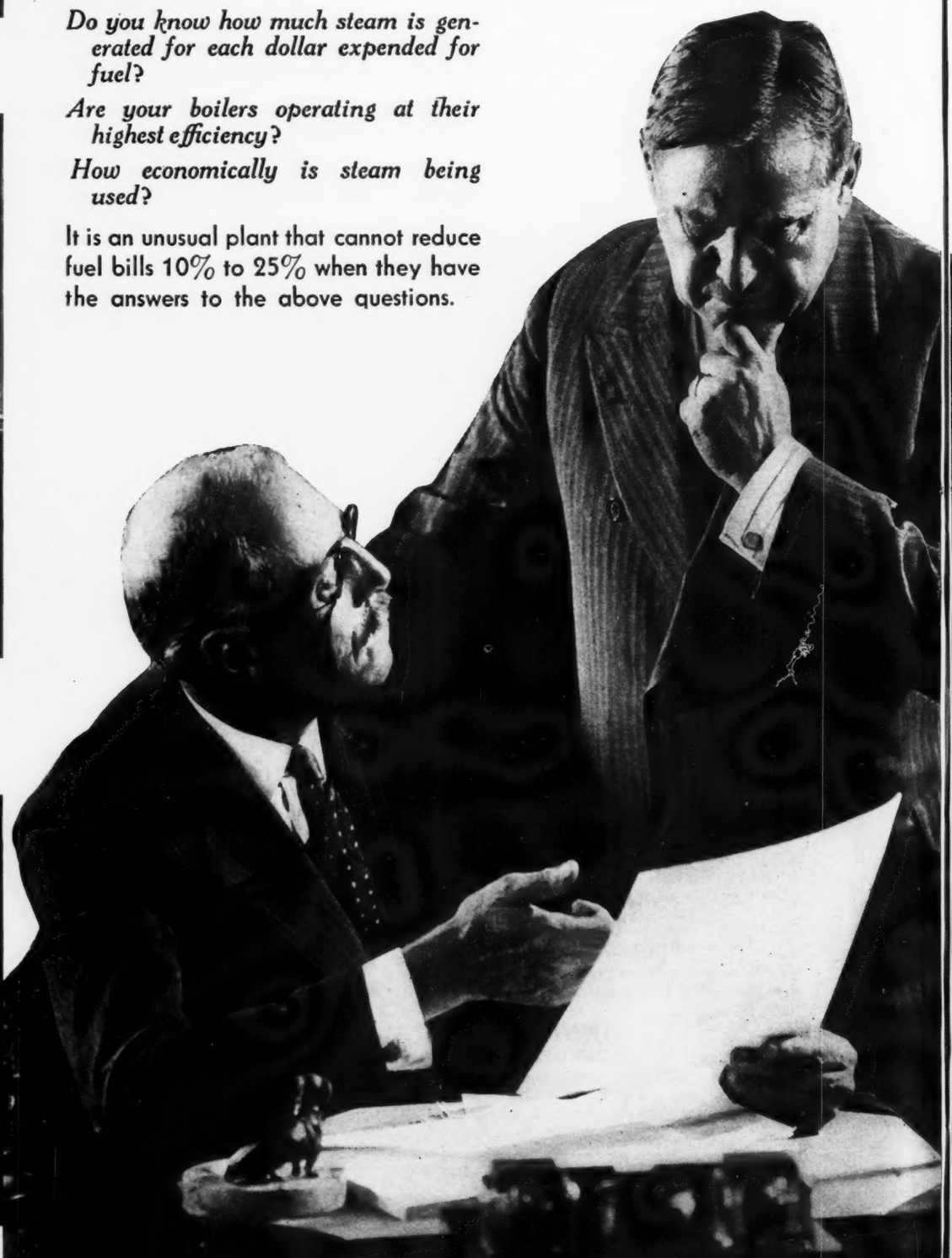
If you use steam for power, process or heating—

Do you know how much steam is generated for each dollar expended for fuel?

Are your boilers operating at their highest efficiency?

How economically is steam being used?

It is an unusual plant that cannot reduce fuel bills 10% to 25% when they have the answers to the above questions.



BROWN INSTRUMENTS and

To Measure and

INTO POWER COSTS . .

WHETHER you burn oil, gas or coal, the starting point toward controlling steam costs is the accurate measurement of flows, temperatures, % CO_2, pressures, drafts and liquid levels. Regardless of the size of the plant, Brown Indicating and Recording Instruments furnish the essential information to operators and engineers that enables them to reduce fuel costs. For example:

In the Boiler Room

BROWN FLOW METERS . . . tell the operators how much steam is generated by each boiler; the amount of water fed to the boilers, and the rate and quantity of blow-down.

BROWN CO_2 METERS AND DRAFT GAUGES . . . when used as a firing guide, enable the operators to hold the correct per cent. CO_2 and prevent fuel losses due to improper air-fuel ratios. Efficient combustion can be maintained only when the operators are guided properly.

BROWN THERMOMETERS AND PYROMETERS . . . are essential guides in checking Flue Gas, Feed Water, Economizer and Superheater Temperatures. They are vital factors in overall operating efficiency.

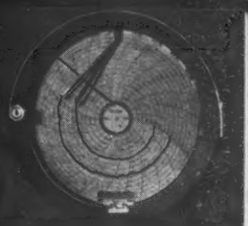
BROWN PRESSURE GAUGES . . . aid in maintaining steam pressures, not only at the boiler, but also in each department.

In the Plant

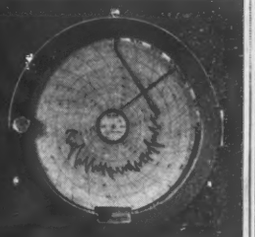
It is good practice not only to provide the operators with Brown Indicating Instruments, but the engineer or plant superintendent with Brown Recording Instruments as well. The continuous chart records reveal instantly any deviation above or below the most efficient operating conditions. By analyzing chart records of flows, temperatures, pressures, per cent. CO_2, liquid levels, management can properly allocate costs and increase the standard of operating efficiency.

For example:—the chart records from Brown Flow Meters not only show the rate and total quantity of steam produced, but the automatic planimeter pen record on the rim of the charts shows the amount of steam used by each department or process for any period of time.

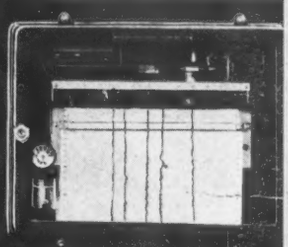
Brown Indicating and Recording Instruments can be mounted on individual panels or grouped on a central control board. Furnished in standard universal cases, adaptable for any style of panel mounting, they present a uniform and well-balanced appearance. Our engineering representatives will be glad to recommend the instruments that will most economically meet your boiler room or plant requirements. Write for Catalog No. 2004. The Brown Instrument Company, *a division of Minneapolis-Honeywell Regulator Co.*, 4490 Wayne Avenue, Philadelphia, Pa. Canadian Factory: 117 Peter St., Toronto, Canada. Branches in all principal cities. European address: Minneapolis-Honeywell Co., Wydesteeg 4, Amsterdam-C, Holland.



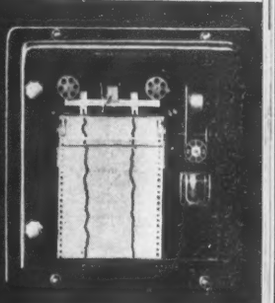
THERMOMETERS



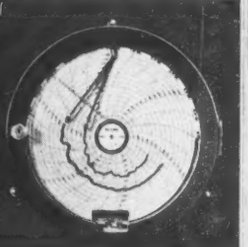
FLOW METERS



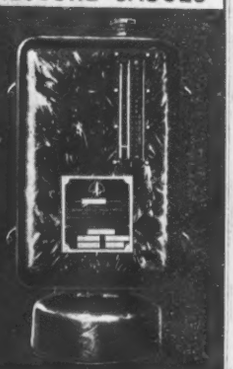
PYROMETERS



% CO_2 METERS



PRESSURE GAUGES



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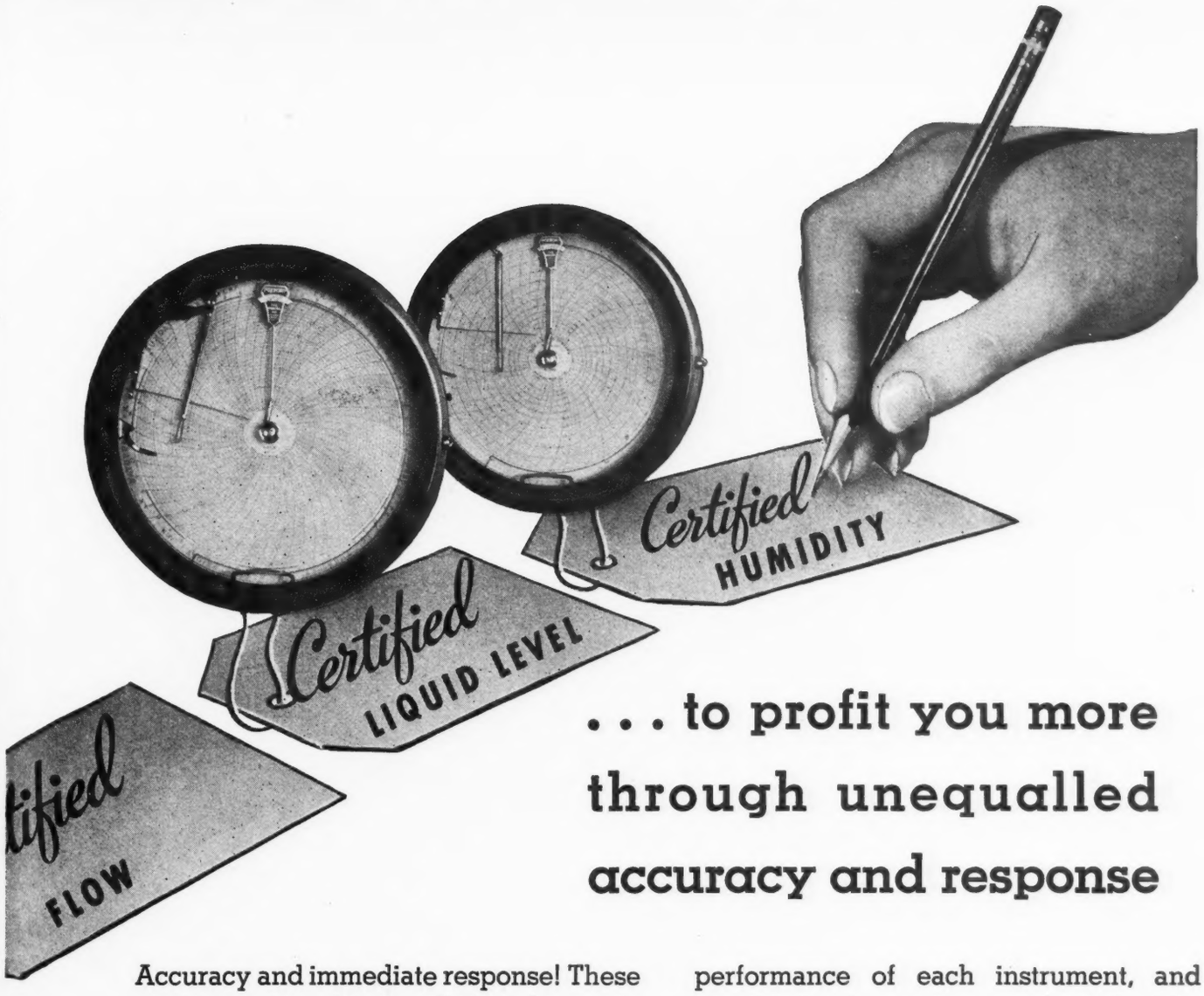
MINNEAPOLIS-HONEYWELL Control System

Control is to Economize

Certified...



. . . to profit you more through unequalled accuracy and response

Accuracy and immediate response! These are two outstanding qualities inherent in Foxboro design and construction. They are the essentials of a true record of conditions – of facts which insure the most economical operation, the best products and the fewest rejects.

Years of research and experience in every possible application have perfected each Foxboro Recorder. Lost motion, sluggish action and all those other detriments to factual records are unknown.

Foxboro *certifies* the performance of each instrument, and thousands of users in every branch of industry know from years of experience that Foxboro Recorders are always alert, active and accurate. They have proof that this accuracy and response endures with a minimum of maintenance and attention.

To those who want facts upon which to obtain maximum operating economies we will gladly send complete information.

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68 Neponset Avenue
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Branches in 25 Principal Cities

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PRESSURE
FLOW
LIQUID LEVEL
HUMIDITY

FOXBORO RECORDERS

RESPONSE FOXBORO *ACCURACY*

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FOSTER WHEELER

Conical ball mills firing three 650 lb. pressure boilers producing 1,200,000 pounds of steam per hour.

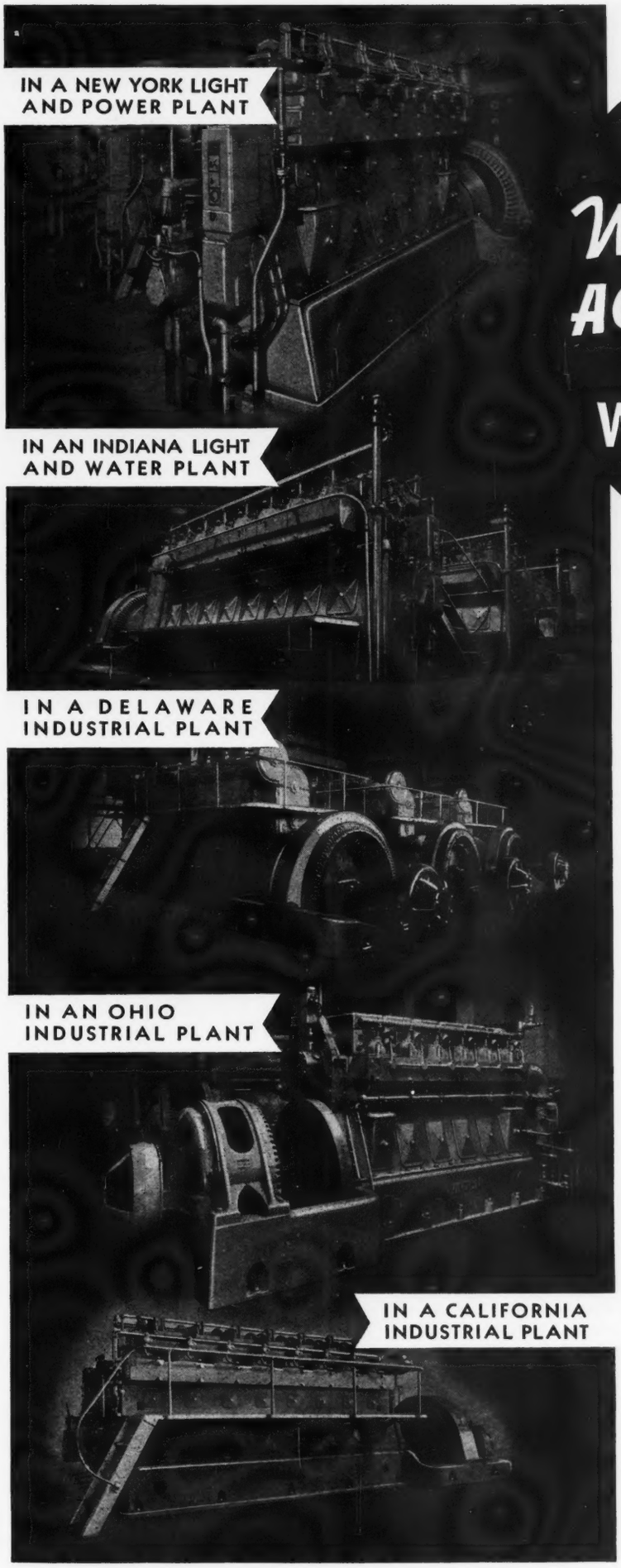
Record Performance Conical Ball Mills

The illustration above shows eight of nine conical ball mills in operation at a large central station. These mills have been in service for more than six years with exceptionally satisfactory results.

Conical ball mill advantages:—

1. Minimum maintenance.
2. Maximum availability.
3. Grinding members renewable while mill is in operation.
4. Mill output independent of coal feed.
5. No lag—mill output instantly controllable.
6. Low speed.
7. Will pulverize at minimum cost by-product coke, anthracite and other low grindability coals.

FOSTER WHEELER CORPORATION, 165 Broadway, New York, N. Y.

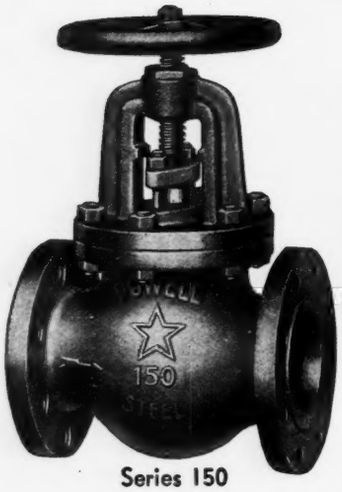

IN A NEW YORK LIGHT AND POWER PLANT
IN AN INDIANA LIGHT AND WATER PLANT
IN A DELAWARE INDUSTRIAL PLANT
IN AN OHIO INDUSTRIAL PLANT
IN A CALIFORNIA INDUSTRIAL PLANT

WHY THE *Wide-Scope* ACCEPTANCE OF WINTON-DIESEL POWER

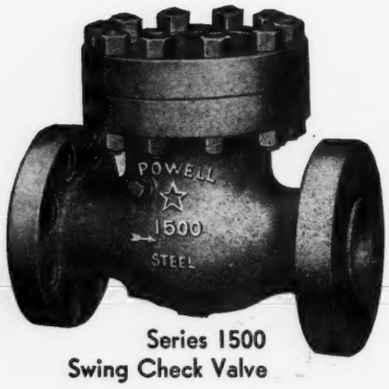
BECAUSE of the exceptional power characteristics of Winton engines, their flexibility, economy, dependability, cleanliness and compactness . . . because of the long and successful experience of Winton engineers in adapting Winton-Diesel units to meet individual power requirements in all types of industrial and municipal plants. These are the reasons why Winton-Diesel power is in demand today in so broad a field of industrial application. These are the reasons why industrial power problems of tomorrow are being conquered by Winton-Diesel power today. Let an experienced Winton representative aid you in solving the power problem in your plant. . . . . Call, write or wire and he will give you immediate cooperation.

WINTON ENGINE CORPORATION

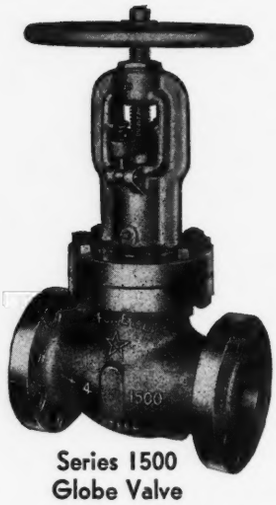
CLEVELAND, OHIO, U. S. A.



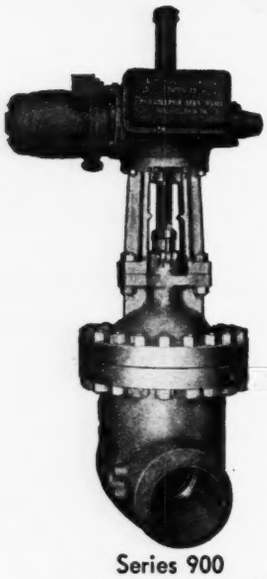
Series 150
Globe Valve



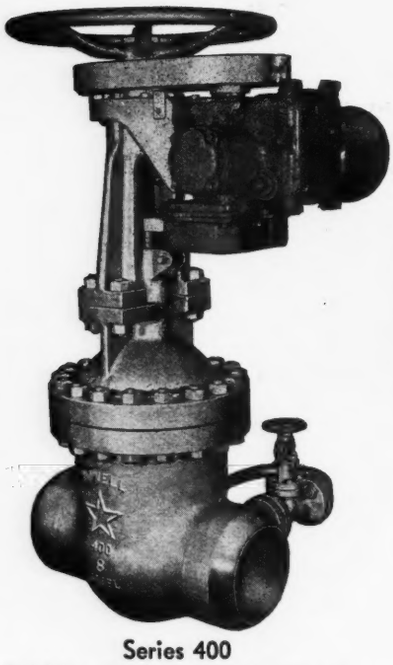
Series 1500
Swing Check Valve



Series 1500
Globe Valve



Series 900
Motor Operated
Gate Valve



Series 400
Welding End Motor Operated
Gate Valve with By-Pass

Series 900
Horizontal Check Valve

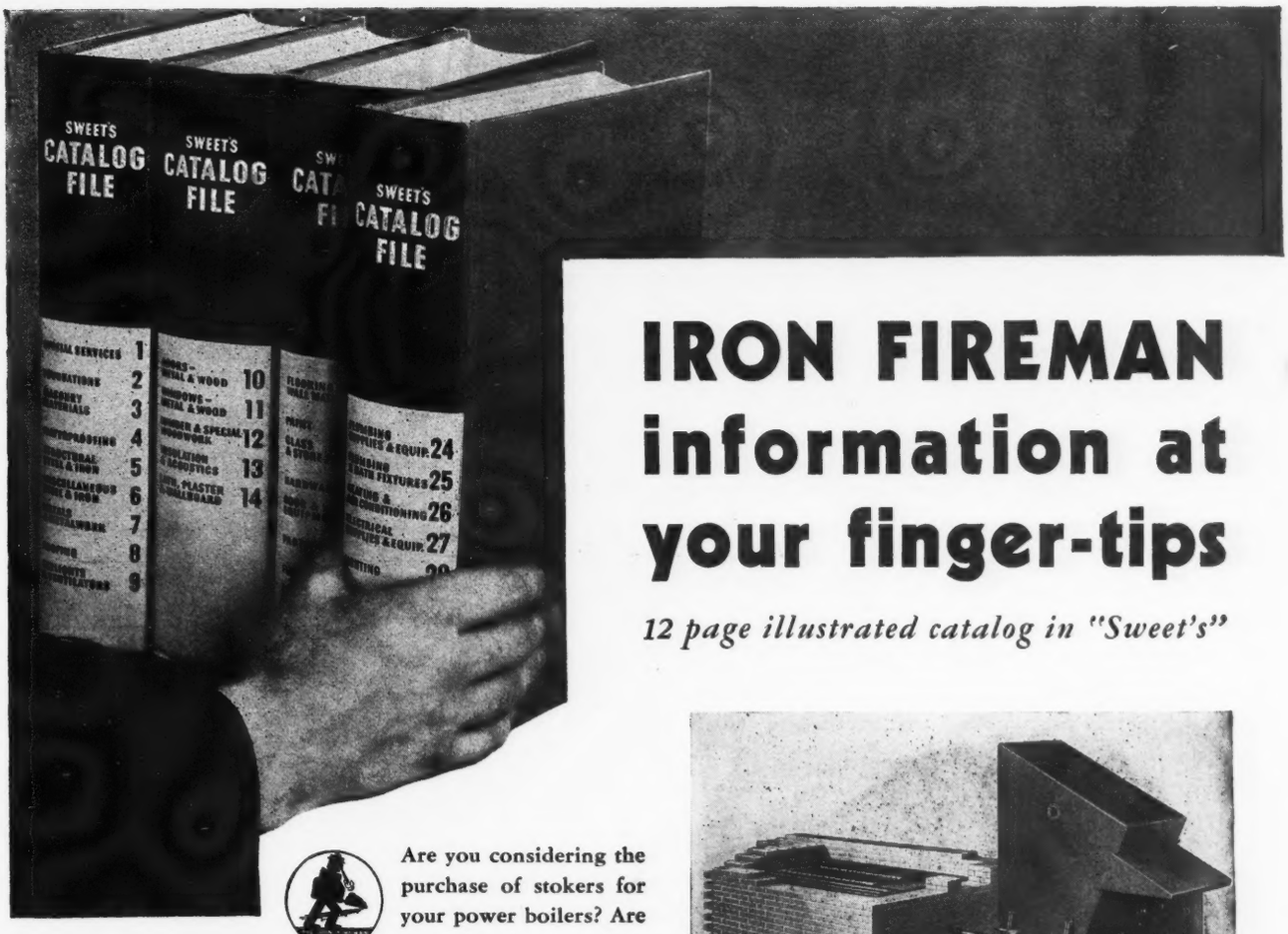
Series 1500
Gate Valve
with By-Pass

POWELL STEEL VALVES

The long life and dependable performance of Powell Steel Valves depend on three essentials — design, workmanship, materials. Each factor of individual importance is given individual consideration. Powell Steel Valves—available in a variety of materials, sizes, and types—are described in detail in Catalog No. 101.

POWELL VALVES

THE WM. POWELL CO. CINCINNATI, OHIO



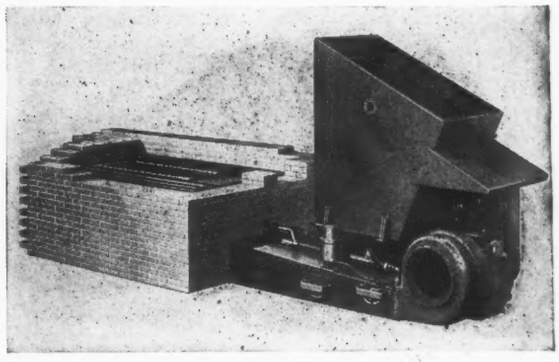
IRON FIREMAN information at your finger-tips

12 page illustrated catalog in "Sweet's"

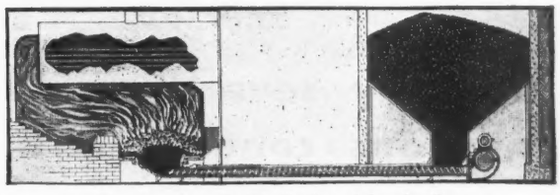
Are you considering the purchase of stokers for your power boilers? Are you planning construction that calls for a new power plant, or an enlargement of your existing equipment? If so, you will want facts on the line of Iron Fireman automatic coal burners for commercial and industrial boilers.

In order that this information can be available in handy, concise form, Iron Fireman has a 12-page illustrated catalog in Sweet's. It includes a brief presentation of the development of automatic coal firing and of the size and scope of the Iron Fireman Manufacturing Company, world's largest makers of automatic coal firing equipment. Basic data and illustrations cover Standard models and "Poweram" models for boilers developing up to 300 h.p. There is a section on design and construction, in which a typical Iron Fireman model is taken apart and the various items of mechanical superiority are illustrated and explained. And last, but by no means least in importance, is the information regarding Iron Fireman's Engineering Department—a specialized division of factory trained engineers whose services are available without cost or obligation.

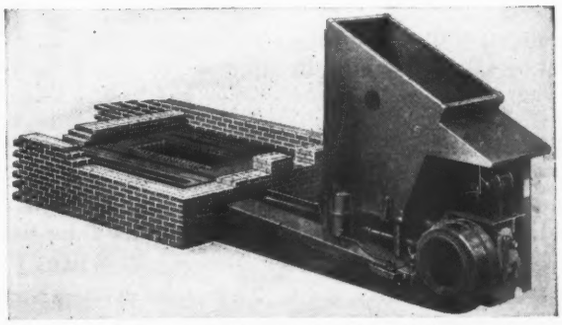
When you want to know about Iron Fireman, reach for your Sweet's. And if further facts are needed, a phone call to your Iron Fireman dealer or a letter to the factory at 3118 W. 106th Street, Cleveland, will get prompt action. Iron Fireman Manufacturing Co. Factories: Cleveland, Ohio; Portland, Oregon; Toronto, Canada. Dealers everywhere.



Typical standard stoker for industrial power and large heating loads. Also available in Bin-Feed models.



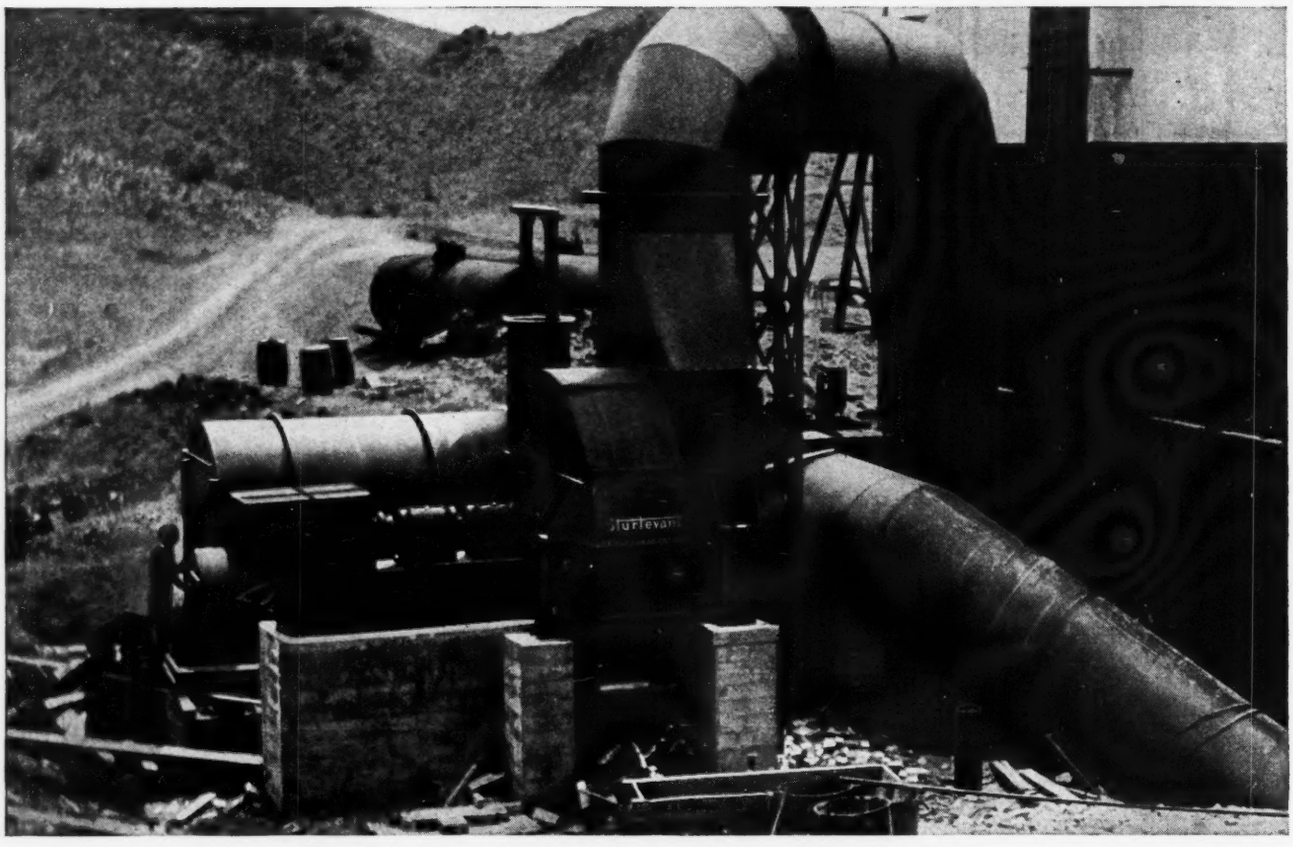
Cross-section of a Bin-Feed model under fire.



The popular Iron Fireman "Poweram" stoker for boilers developing up to 300 h.p. Available in Bin-Feed models.

IRON FIREMAN AUTOMATIC COAL FIRING EQUIPMENT

Flue Gas at 1300° F.
handled by Sturtevant Fan



Stress relieving furnace at field pipe fabricating plant of Babcock & Wilcox Co., Boulder Dam. Built by Rust Engineering Co., Pittsburgh, Pa. Flue Gas recirculating fan by Sturtevant.

Extremely severe service conditions conquered by Sturtevant Fan Engineering

Gas temperature...1300° Fahr. Volume...65000 cubic feet of gas per minute. Peripheral fan speed...over 12,000 f.p.m.

These were the operating conditions met by the Sturtevant Fan shown above. It recirculated fuel oil combustion gases in a furnace for stress-relieving fusion-welded steel pipes, at the Boulder Dam field pipe fabricating plant of the Babcock & Wilcox Co. Pipes handled were up to 30 feet in diameter and weighed as much as 150 tons.

This fan presented a real problem in fan engineering. Due to the expansion of the metal at the very high temperatures encountered, it called for special design throughout, the use of alloy steels, and careful heat treatment.

Years of experience, a thorough knowledge of alloy steels and heat treatment, and special heat treating facilities make Sturtevant especially well-equipped to solve the tough fan problems—whether the requirements include high temperature, high pressure, high speed or large volume.

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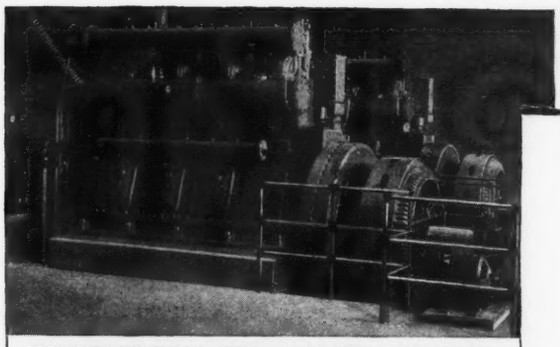
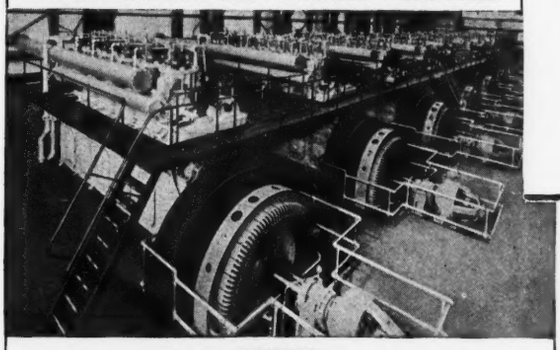
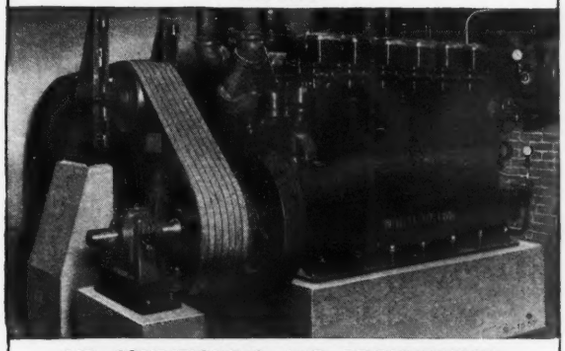


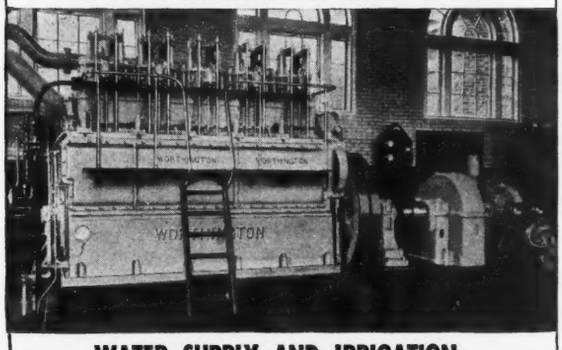
MANUFACTURING AND PROCESS INDUSTRIES



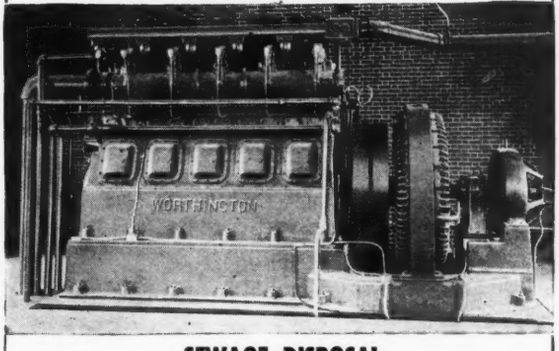
MINING



AIR CONDITIONING AND REFRIGERATION



WATER SUPPLY AND IRRIGATION



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+ LONG TANGENTS

1¼" per inch of fitting diameter. Advantages: (1) Pipe and Ell are lined up more quickly and accurately—thus reducing installation time and cost. (2) Short nipples and the extra welds they require are frequently eliminated. (3) Etc.

+ SAVING IN PIPE

When a 12" Midwest Ell is used, the tangents alone save 6" of pipe, while the radius of 1½ nominal diameters (instead of one nominal diameter) is responsible for an additional saving of 12" of pipe.

+ LARGE RADIUS

Radius is 1½ times nominal diameter instead of being only equal to nominal diameter. Larger radius makes welding more convenient and reduces installation time. It also saves pipe and eliminates excessive pressure drop.

+ DIMENSIONAL ACCURACY

and uniformity not otherwise possible result from final working in compression.

+ STRESS RELIEVED

Midwest Ells are first made slightly over-size. They are then reheated to a forging heat and reduced to correct size in compression.

+ UNIFORM WALL THICKNESS

results from the manufacturing process which is used exclusively by Midwest.

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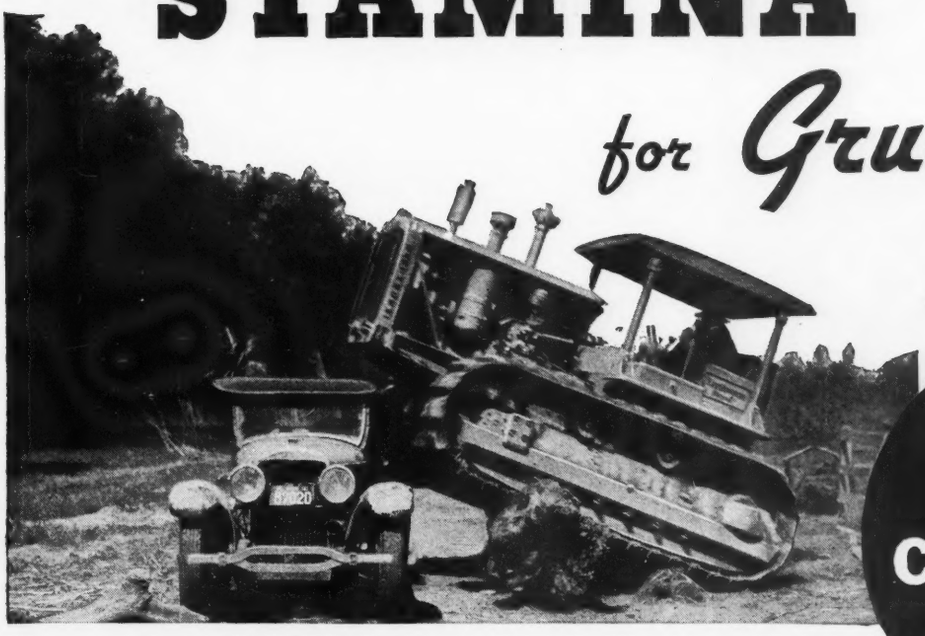
STAMINA

for Grueling Service



NICKEL CAST IRON

● Diesels must handle a wide variety of tough jobs. But these jobs have one thing in common: they all demand a high degree of stamina—and that means in the metals of which the Diesels are built.

Diesel cylinder heads, pistons, liners and rings must have a dense non-porous structure, an evenness and uniformity which until recently no one looked for in cast iron. But small additions of Nickel or Nickel and chromium so improve the properties of this metal that it is rapidly becoming a trusted stand-by for Diesel construction.

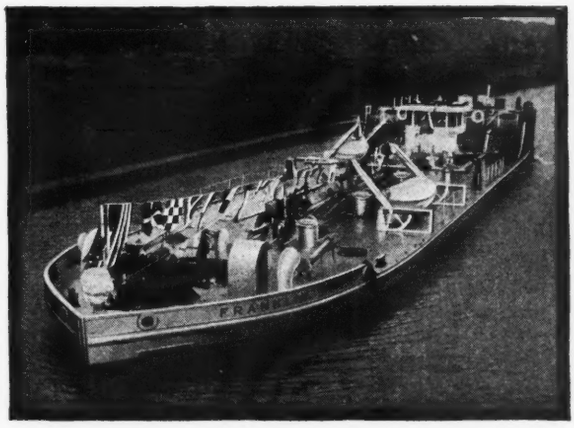
If you need a tensile strength of 50,000 p.s.i. —as did the Diesel in the power shovel shown here—you can obtain it with Nickel Cast Iron. If wear resistance and a minimizing of "growth" under heat is your special problem, you can improve these properties with Nickel additions.

You MUST get the alloy best suited to your special job. The wide experience of the Inco engineers is wholly at your service. Write them.

One of the several "Caterpillar" tractors recently used in the gruelling work called for in Warner Bros.' film, "Earthworm Tractors." The Diesels used in "Caterpillars" all have cylinder heads and liners, piston rings and starting engine crank-shafts of Nickel Cast Iron.

This "Lima" power shovel, working on the Colorado River aqueduct, is driven by a Waukesha Hesselman type engine. These solid injection, spark-ignition oil-engines make severe demands—but Waukesha Motor Company meets them by casting cylinder heads with a minimum tensile strength of 50,000 p. s. i. The formula they use to get this result:

Silicon	1.80–2.00%	Total Carbon	2.80–3.00%
Nickel	1.20–1.30%	Chromium	0.30–0.40%



• • •

The Diesel-electric oil tanker "Franklin," on her maiden voyage. Gears, pistons, cylinder heads, water pump castings and frames of her Diesels are Nickel or Nickel-chromium Cast Iron. The makers, McIntosh & Seymour Corp., Auburn, N. Y., also used Nickel Alloy Steels for several parts subjected to great stress.

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It works in the power plant field as well as in any other. Some men fit themselves to do a little more than their job calls for. They fit themselves to do a little more than the other fellow. They make a steady effort to equip themselves with the best kind of job insurance there is—KNOWLEDGE.

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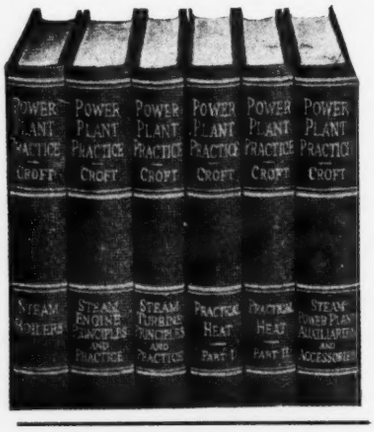

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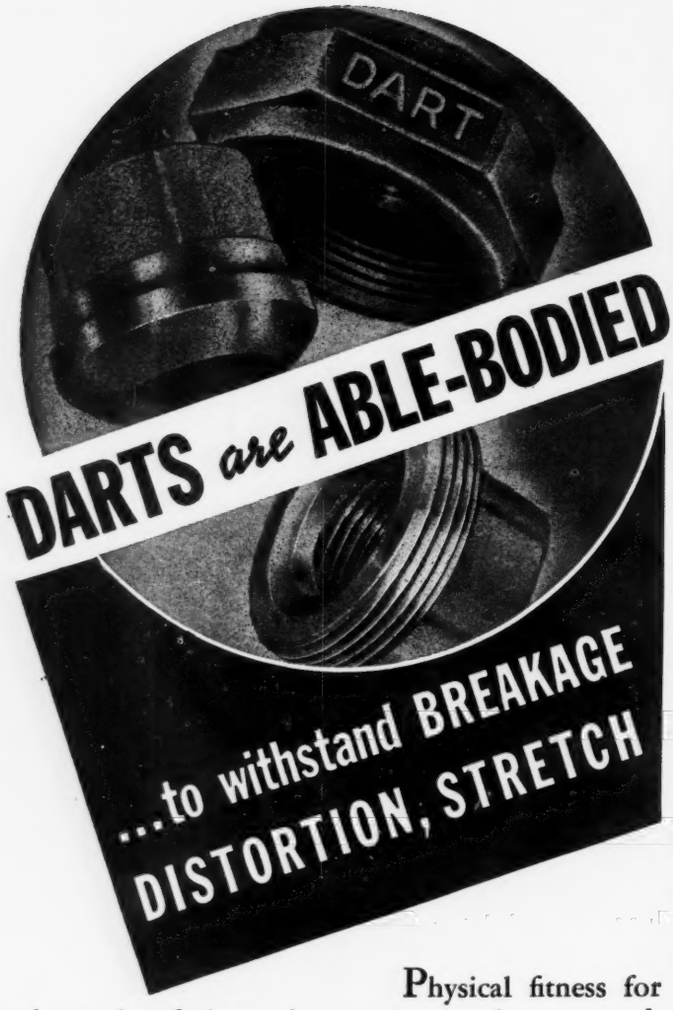

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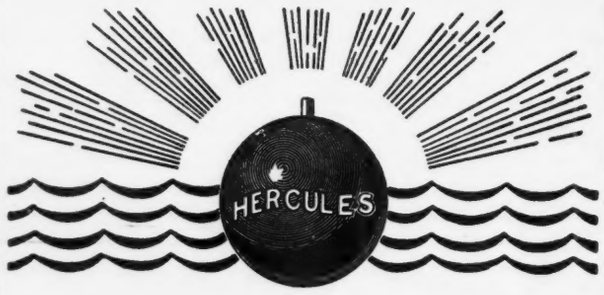

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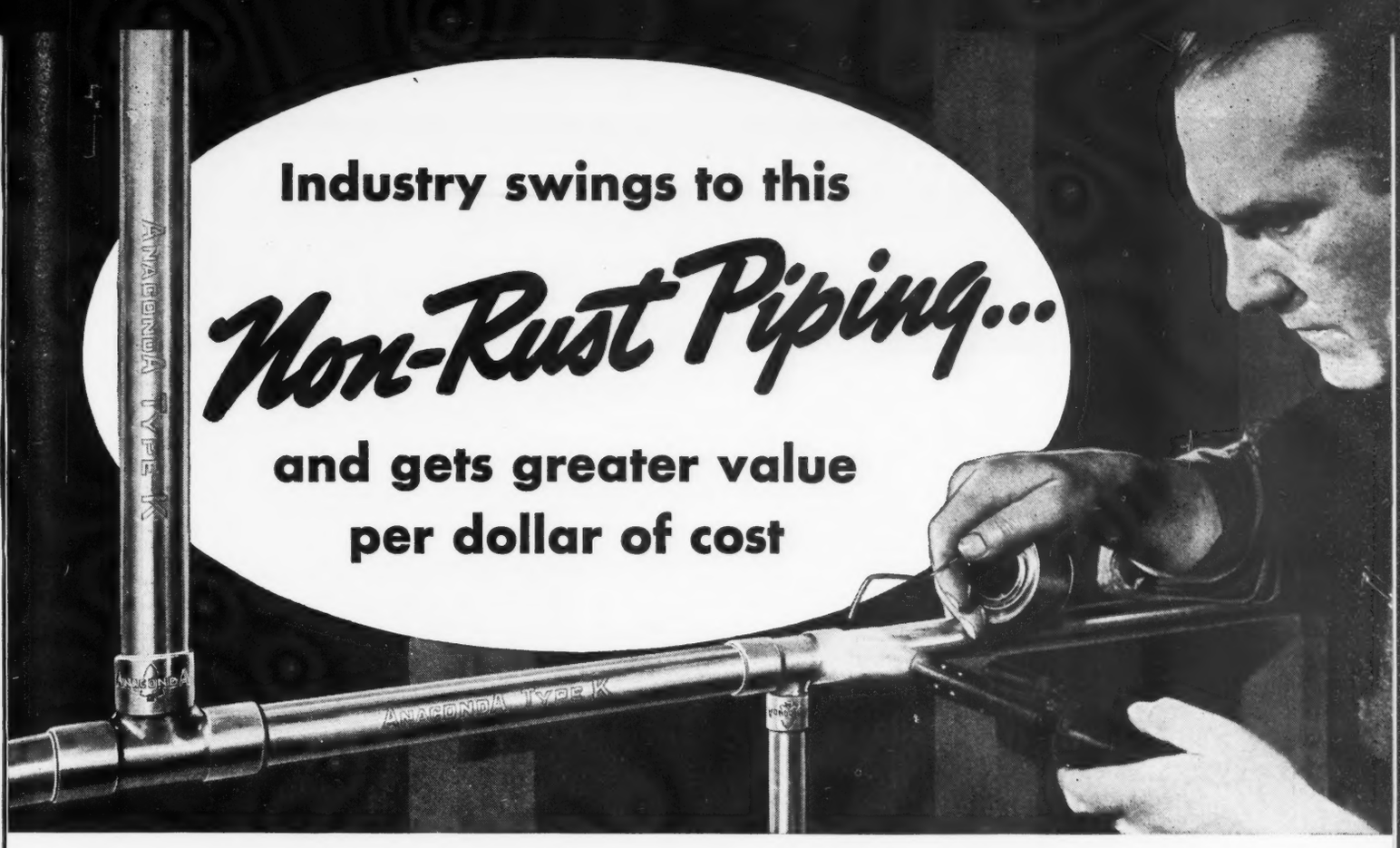

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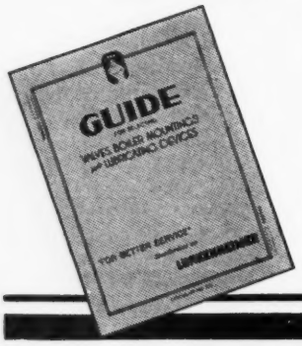
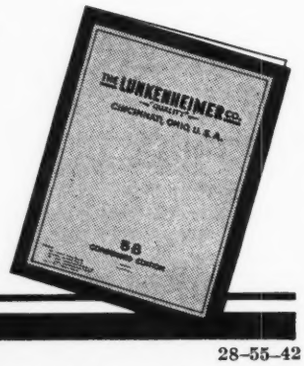


The Guide is a ready reference for selecting Valves, Boiler Mountings and Lubricating Devices in which products are grouped by pressure, type and use. The catalog describes and lists the Lunkenheimer line. Ask the distributor for copies or write us direct.



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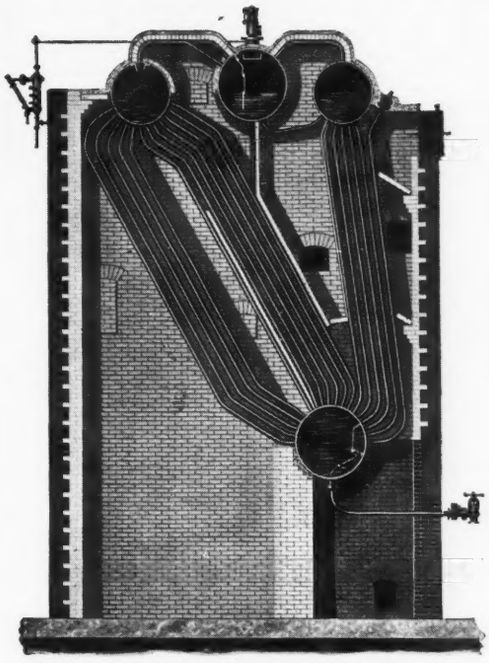

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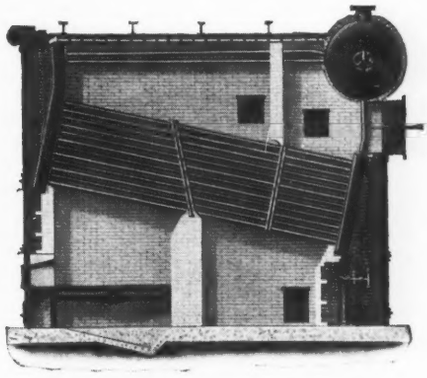

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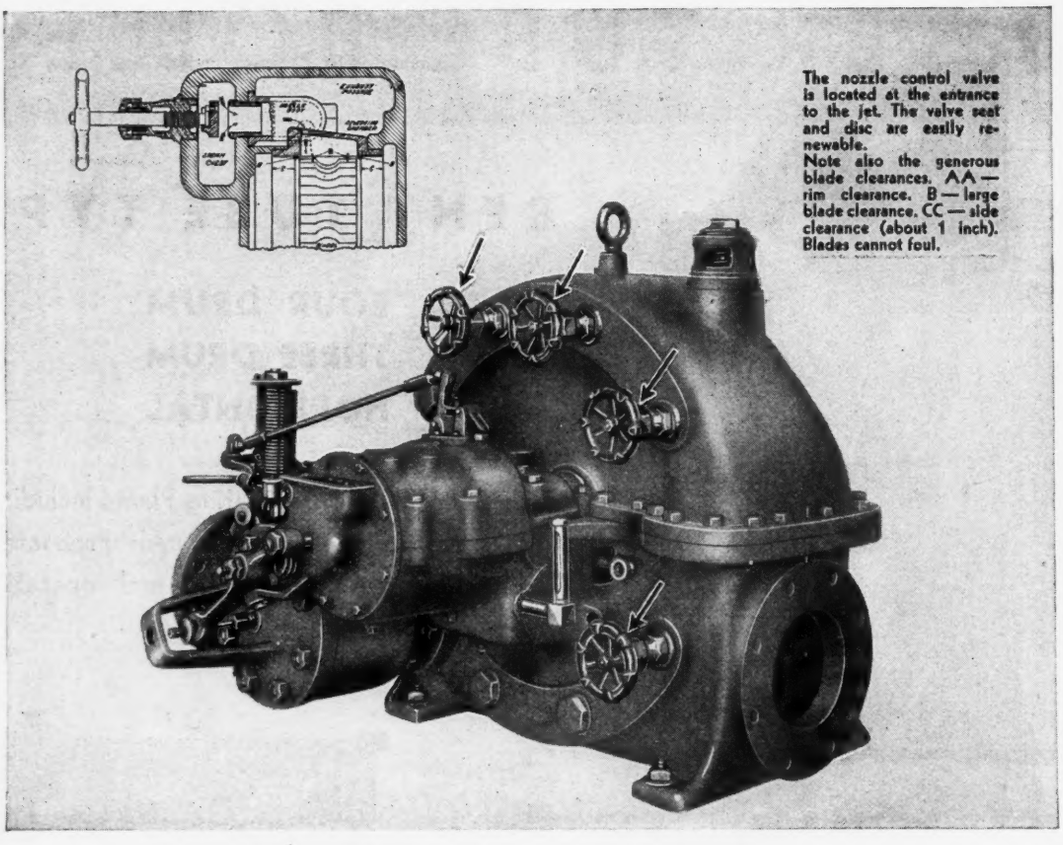
The nozzle control valve is located at the entrance to the jet. The valve seat and disc are easily renewable.
Note also the generous blade clearances. AA — rim clearance. B — large blade clearance. CC — side clearance (about 1 inch). Blades cannot foul.

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In the Terry Solid Wheel Turbine each nozzle acts independently of the others and produces its own portion of the total power.

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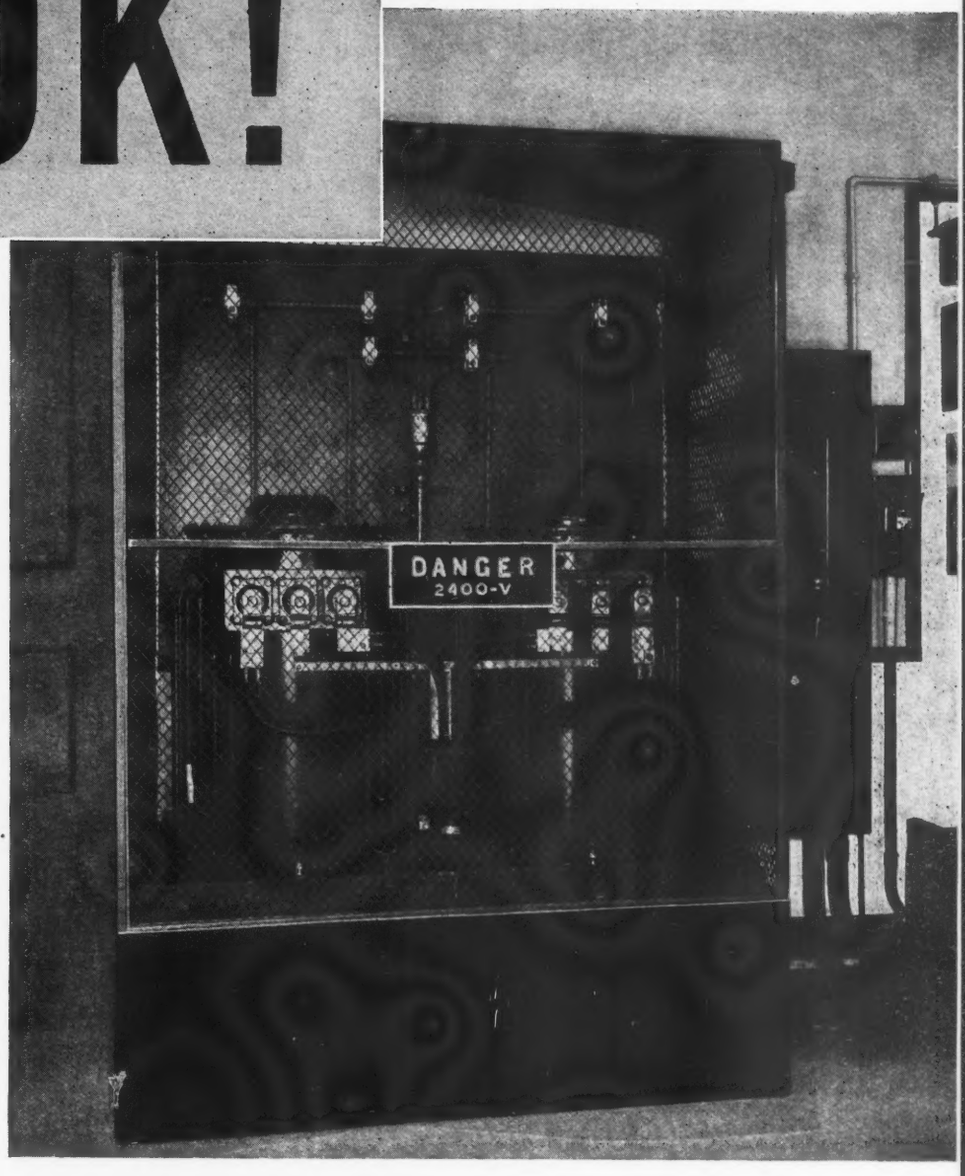

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300-45

GENERAL ELECTRIC

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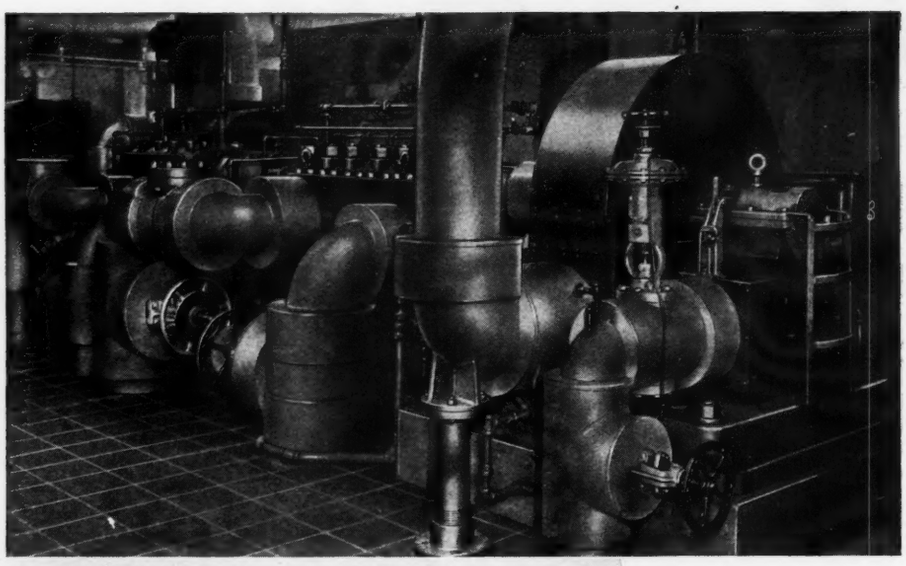

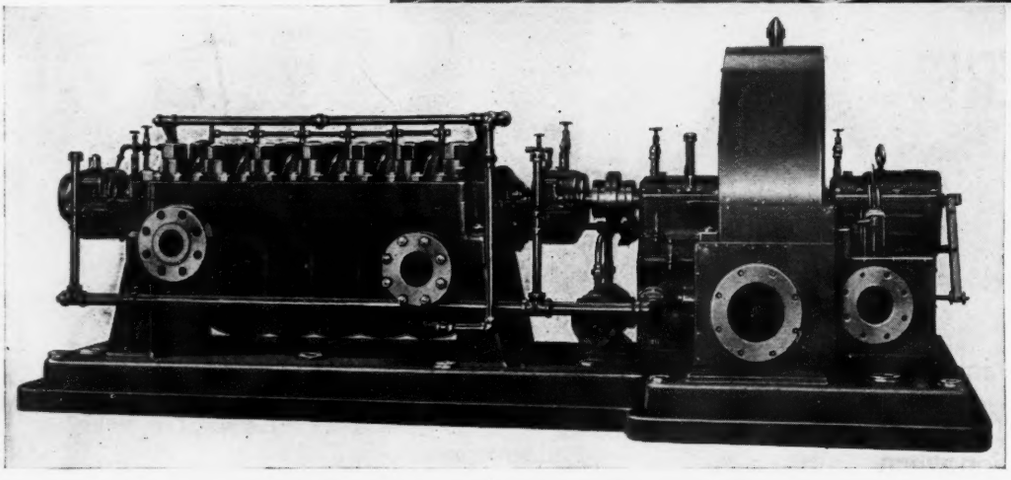

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Texrope Drives
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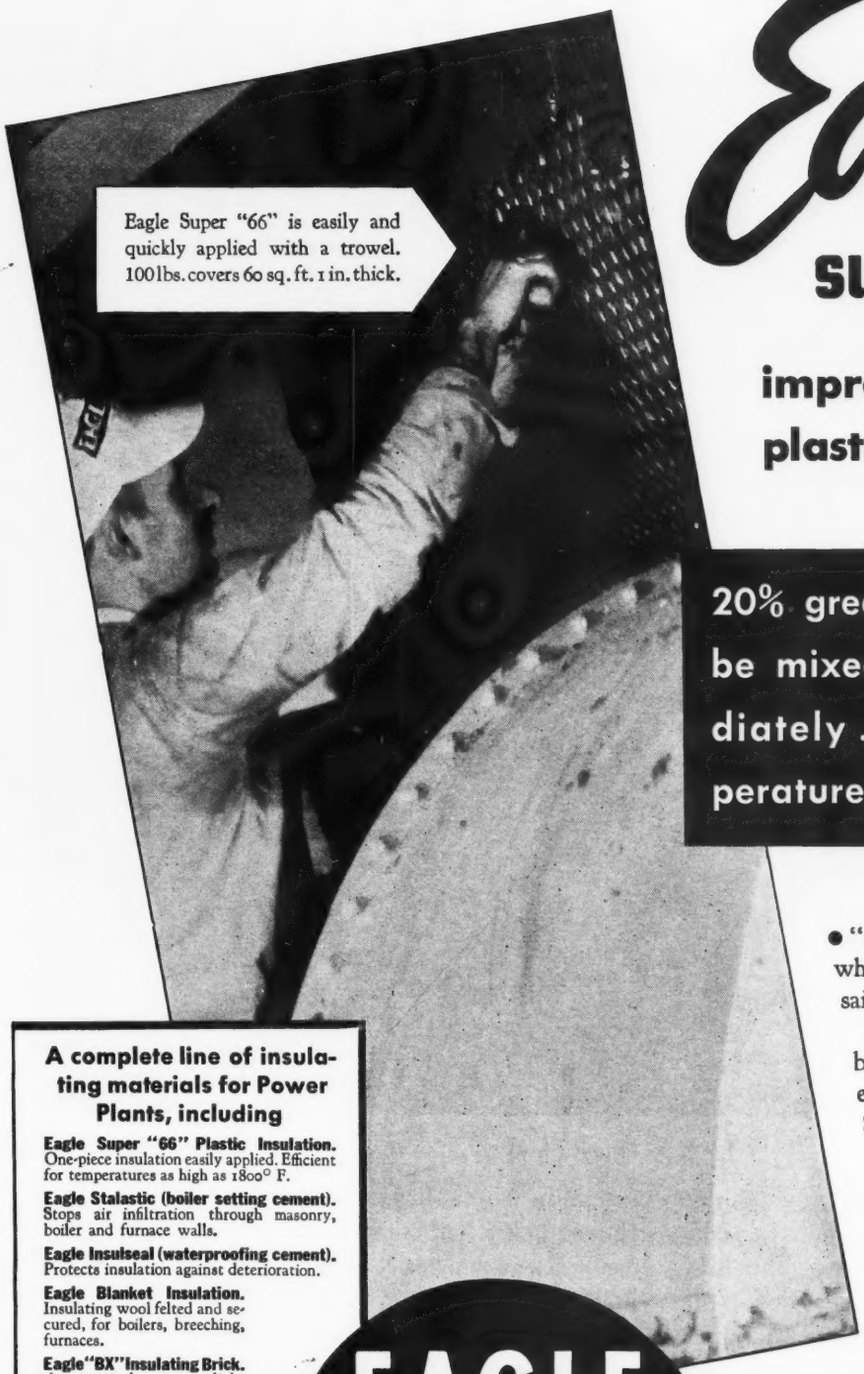
EQUIPMENT ENGINEERS TO INDUSTRY
ALLIS-CHALMERS
MILWAUKEE WISCONSIN

Bulletins for various types of equipment furnished on request. Address Allis-Chalmers Mfg. Company, Milwaukee, Wisconsin

INSULATION COSTS CUT BY

Eagle super "66"

improved all-purpose plastic insulation...



20% greater coverage . . . can be mixed and applied immediately . . . efficient for temperatures as high as 1800° F.

● "A perfect insulation for our use!" That's what industrial engineers all over the country said of Eagle "66".

Now this efficient plastic insulation has been made even easier to apply—given even greater coverage. The result is Eagle Super "66".

This *improved* insulation costs no more than Eagle "66". Mix it with water and it's ready to trowel on at once. Sticks like glue to hot surfaces. No joints to open up and let out heat. Shrinkage has been greatly reduced. The most economical insulation there is for air ducts, boilers, etc.

Mail coupon today for complete specifications and sample.

A complete line of insulating materials for Power Plants, including

Eagle Super "66" Plastic Insulation. One-piece insulation easily applied. Efficient for temperatures as high as 1800° F.

Eagle Stalastic (boiler setting cement). Stops air infiltration through masonry, boiler and furnace walls.

Eagle Insulseal (waterproofing cement). Protects insulation against deterioration.

Eagle Blanket Insulation. Insulating wool felted and secured, for boilers, breeching, furnaces.

Eagle "BX" Insulating Brick. An extremely strong, light weight insulating brick. Easy to cut. Resists spalling. For temperatures up to 2500° F.

Eagle "Verox" Insulating Brick. A light weight, efficient insulating brick for backing up refractory walls or roofs. For temperatures up to 2000° F.

EAGLE INDUSTRIAL INSULATION

The Eagle-Picher Lead Company, Dept. P12, Cincinnati, Ohio

Please send me free sample of Eagle Super "66" Plastic Insulation; also descriptive catalog.

*Name*_____

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*City*_____ *State*_____

Wheels roll easily on this non-skid floor plate

Multigrip floor plate offers a good half dozen advantages—at no extra cost. The design and spacing of the lugs make Multigrip safe, and easy to stand or walk on. It resists skids from all angles. Easy to clean—there are no pockets in which dirt might catch. It drains quickly and completely. It cuts economically and hence is well adapted for use on both small or large areas. Write for details of the profit-opportunity that is yours with Multigrip.

MULTIGRIP FLOOR PLATE

Carnegie-Illinois Steel Corporation • Pittsburgh • Chicago

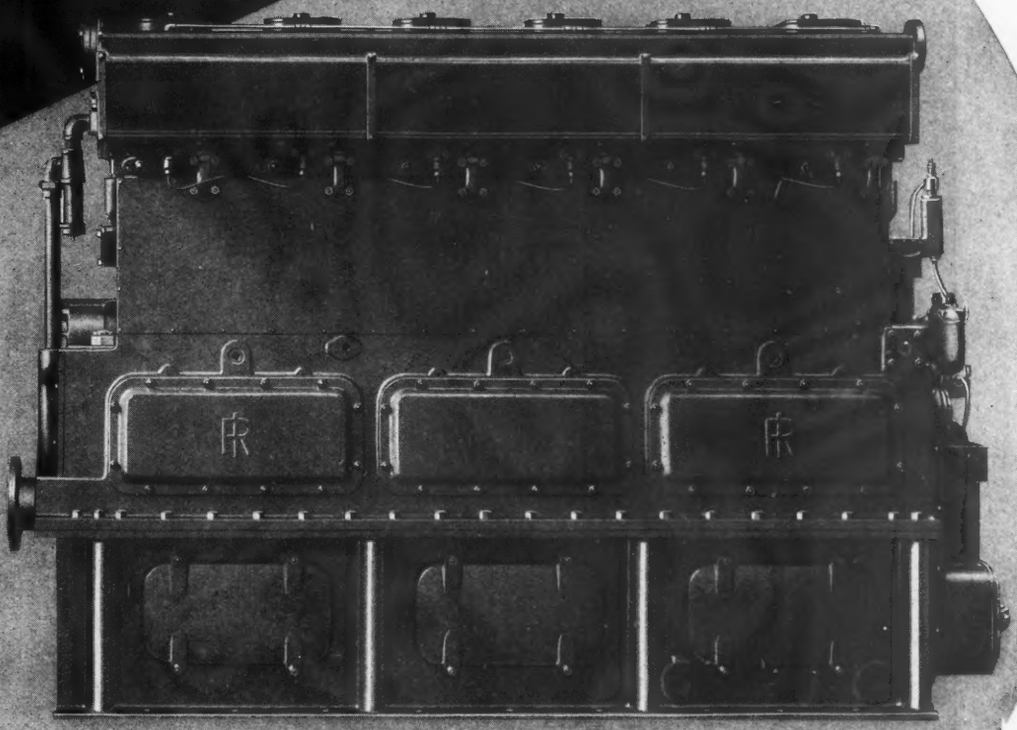
Pacific Coast Distributors
Columbia Steel Company, San Francisco

Export Distributors
United States Steel Products Co., New York

UNITED STATES STEEL

The MODERN DIESEL

Type "S"



A few of the many advantages of Type S Diesels:

1. MODERN DESIGN
2. LOWER FUEL CONSUMPTION
3. LOWER INSTALLATION COSTS
4. MORE EFFICIENT POWER TRANSMISSION
5. INEXPENSIVE TO MAINTAIN
6. A THOROUGHLY PROVED ENGINE

MODERN DESIGN

- FULLY ENCLOSED MODERN DESIGN
- WELL BALANCED CONSTRUCTION
- EASILY ACCESSIBLE WORKING PARTS

THE Ingersoll-Rand Type S Diesel engine is an improved unit which is thoroughly modern in all respects. The fundamental design is similar to that of the successful I-R locomotive engine of which there are more than 140 in operation. Some of these have been in service for over 12 years.

The new Type S is the culmination of a vast amount of research and experience gained during 16 years of building outstanding solid-injection Diesels. Some of the modern features of its design are: full enclosure of the engine, cylinder liners, balanced construction throughout, lower weight, and high-speed performance without sacrifice of long life and reliability.

Type S engines are made with 3, 4, 5, 6 and 8 cylinders for ratings from 150 to 460 hp. Get in touch with our nearest branch office today and ask to have one of our engineers tell you more about this engine. Write for Bulletin 10010.

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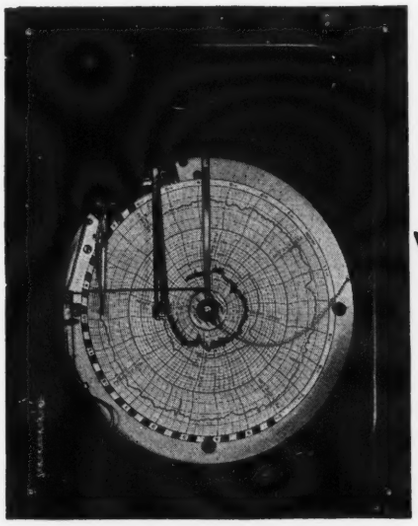
Roebling...
The pacemaker in wire rope development
JAR
THE most exacting basis for judging wire rope performance is AVERAGE SERVICE.
This is the basis advocated by Roebling, in which rope cost per mile of elevator travel or per other unit of service measurement, is based not on the service of a single rope but on the *average* service of several ropes.
John A. Roebling's Sons Co., Trenton New Jersey

EFFICIENCY UP

with HAYS COMBUSTION INSTRUMENTS

FUEL COSTS DOWN



The major expense of steam generation is FUEL; a very minor investment in the slight cost of combustion efficiency instruments will keep fuel costs where they belong. Here are a few of the HAYS instruments, vital to the control of your major expense—FUEL.

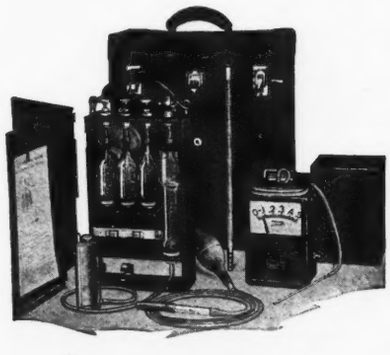
COMBUSTION METERS

The percentage of carbon dioxide in the flue gas talks DIRECTLY about combustion efficiency and fuel economy. The automatic Orsat principle of volumetric analysis leaves nothing to inference, computation or theory. Hays automatic combustion meters have no moving parts in the analyzing section—no friction except fluid friction. A simple pneumatic transmission makes it possible to mount the recording section on the wall or in an instrument and control panel as illustrated.

The modern way of mounting instruments is on a centralized panel with the automatic combustion control equipment as illustrated.

DRAFT GAGES

Hays pioneered the dry type slack-diaphragm pointer gage for draft and pressure and can now supply it in all types, including rectangular and fan shaped cases for separate wall mounting, and the close-nesting, vertical type illustrated above, for panel mounting. Portable draft gages are also available. The same sensitive, accurate mechanism is used in the Hays draft recorder. Smooth pointer movement and extreme accuracy are characteristic of the Hays dry type slack-diaphragm draft gages and draft recorders.



COMBUSTION TEST SETS

For diagnosing work "spotting" and correcting excess air infiltration, faulty baffling or soot-clogged passages, the Hays portable combustion test set is ideal for both the consulting engineer and the plant man. The complete test set shown includes a three chamber Orsat analyzer for CO_2, oxygen and carbon monoxide, a flue gas thermometer and a portable pointer type draft gage.

MAIL THIS COUPON

THE HAYS CORPORATION
Michigan City, Indiana

Please send me details on the items checked.

COMBUSTION METERS.....DRAFT GAGES.....
TEST SETS.....

Name .....

Position .....

Company .....

Address.....

THE HAYS CORPORATION

COMBUSTION · INSTRUMENTS SINCE 1901 ·

MICHIGAN CITY, INDIANA

Pub. No. 36-137

A TRAP FOR EVERY PURPOSE

STANDARD TRAPS

The majority of all trapping jobs can be handled with *complete satisfaction* by the seven standard size Armstrong Steam Traps ranging from the little No. 200 (or 201) up to the big No. 216. All of these traps are available with the *exclusive* automatic air by-pass for fast heating blast trap service. Write for the Armstrong Steam Trap Book telling where, why and how to use these traps.

SPECIAL TRAPS

PULSATING PRESSURES—Engine separators, etc., should be drained by traps, No. 223, 225 or 226, which feature the special separating chamber that protects trap valve mechanism from pulsations.

SUPER-CAPACITY — Armstrong Compound Traps are available to handle virtually unlimited volumes of condensate. Three standard sizes for low and medium pressures, and for high pressure. Larger sizes built on order.

AIR TRAPS

Armstrong makes a complete line of traps for discharging air, or other non-condensible gas, from water or other liquids. Removal of water from compressed air and deaerating closed water systems are typical applications. Ask for a copy of the new Armstrong Air Trap Bulletin. It describes numerous interesting applications.

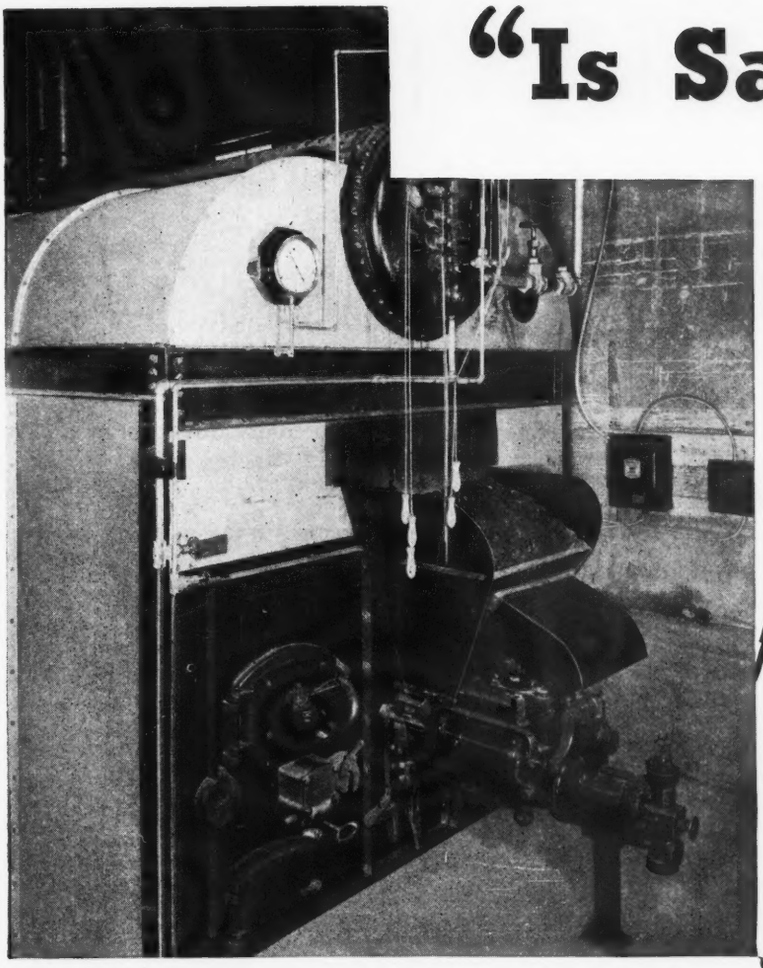
HIGH PRESSURE

Standard Armstrong Forged Steel Traps are made in three sizes for pressures up to 1500 lbs. (Higher pressures built on order.) Each trap is tested at 3000 lbs. hydrostatic pressure. These traps are now available with integral flanges to conform to either American or Navy standards. Specification sheets on request.

ARMSTRONG MACHINE WORKS

812 Maple Street — Three Rivers, Mich.

"Is Saving 35% in Fuel"



According to Mr. Zeck's letter this Series 70 "F&E" Underfeed Stoker, replacing "an underfeed stoker of another make . . . . is saving about 35 per cent in fuel cost."

PITTSBURGH LAUNDRY INC.
WYANDOTTE STREET AT FIFTH AVENUE
PITTSBURGH, PA.

Flynn and Emrich Co.,
Baltimore, Maryland

August 27, 1936

Gentlemen:

We wish to express to you our satisfaction with our F & E underfeed stoker purchased from you some months ago. This machine as you may know replaced an underfeed stoker of another make and is saving about 35% in fuel over this other equipment.

In addition, we have eliminated our smoke and fly-ash troubles as well as mechanical difficulties experienced with our previous stoker equipment, even though we are now burning a cheaper grade of coal on our F & E stoker.

We are well pleased with the service rendered us by your Mr. Bockius while this installation was being made and when it was placed in operation and as we have told him, you can feel free to refer anyone interested in the purchase of stokers to us.

Yours very truly,
PITTSBURGH LAUNDRY, INC.
R. C. Zeck
Secretary

RCZ:HS

WITH over twenty years' experience in the manufacture and installation of automatic stokers, and with approximately 6 million boiler horse-power equipped with its stokers, FLYNN & EMRICH COMPANY offers an incomparable line of underfeed stokers in three distinct classes:

"70 Series"—Heavy Duty Industrial Stokers
"60 Series"—Industrial Series
"50 Series"—Commercial Stokers

Only in "F&E" Underfeed Stokers, both electric or steam drives, is found the combination of five advanced engineering features described at the right. *Use the Coupon* below to secure the new Catalog.

Five Outstanding Features

- **Interval Timer Governor**—Giving that full stroke full speed ram action and an infinite number of coal feed adjustments.
- **Foolproof** against **breakdowns** if tramp iron or other obstructions are fed in with the coal.
- **Sliding Bottom Retort**—For better underfeed coal distribution—immune to warping.
- **Fuel Bed Control**—Regulates stroke of sliding bottom, thus controlling distribution of fuel bed to meet varying coal conditions.
- **Zoned Air Distribution**—Forced Air to entire stoker surface under zoned damper control.

"F&E" UNDERFEED STOKERS

Manufactured By

FLYNN & EMRICH COMPANY
ESTABLISHED 1842

BALTIMORE, MARYLAND

F&E

FLYNN & EMRICH COMPANY - - BALTIMORE, MARYLAND

Please send us your new free 12-page CATALOG, describing in detail:

☐ SERIES 70 "F&E" Underfeed Stoker, heavy duty type.
☐ SERIES 50 and 60, commercial and moderate-load industrial types, respectively.

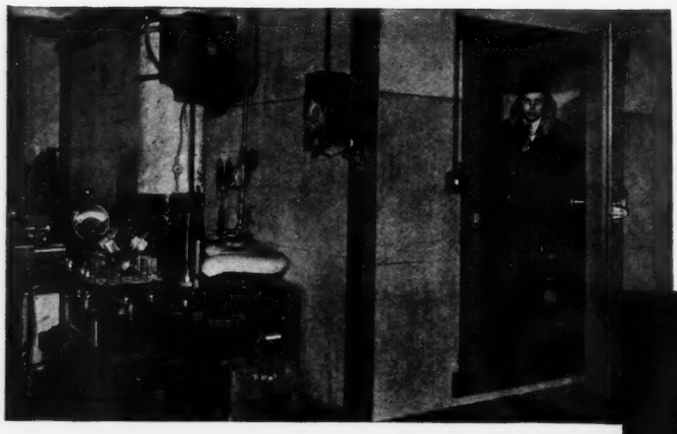
NAME..... TITLE.....

COMPANY.....

ADDRESS..... P 12

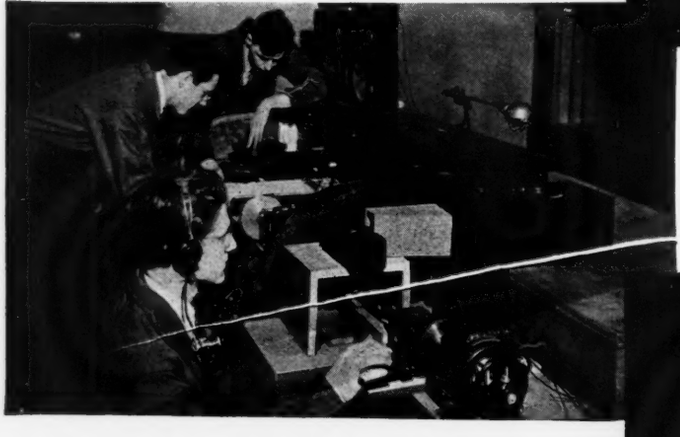
Headquarters for the facts

on DIESEL ENGINE STARTING

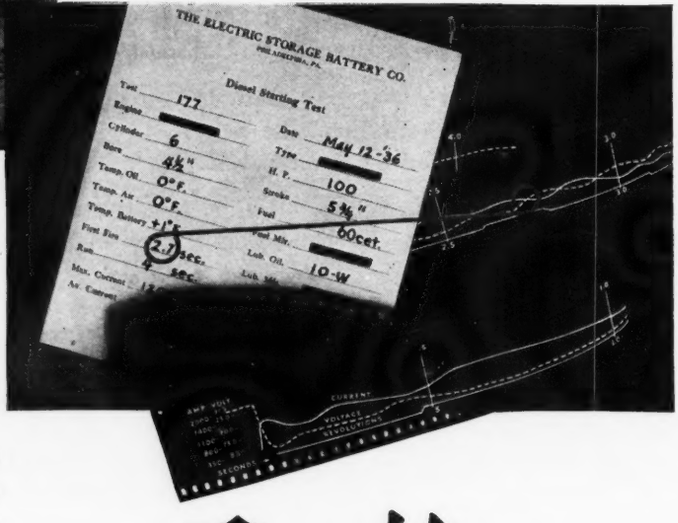


INSIDE Exide's specially-built cold-chamber, Diesel engine, electric starting system and battery alike can be cooled far below zero and held at that point indefinitely, in order to duplicate the most severe conditions to be met in actual service.

Arctic weather—what is the maximum power required to start the particular type of engine under test? How many seconds before it fires and runs regularly? What size and type of battery is needed to assure unfailing performance in the hands of Diesel engine users?



By means of special instruments whose readings are photographically recorded, measurements are taken at split-second time-intervals—providing nearly 100 times more accurate data than by ordinary methods.



"Fire, 2.7 seconds," says the oscillograph record on Test No. 177. Here is shown the form in which the data appears. From this the significant facts are readily determined for any type of Diesel engine under any given conditions.

●

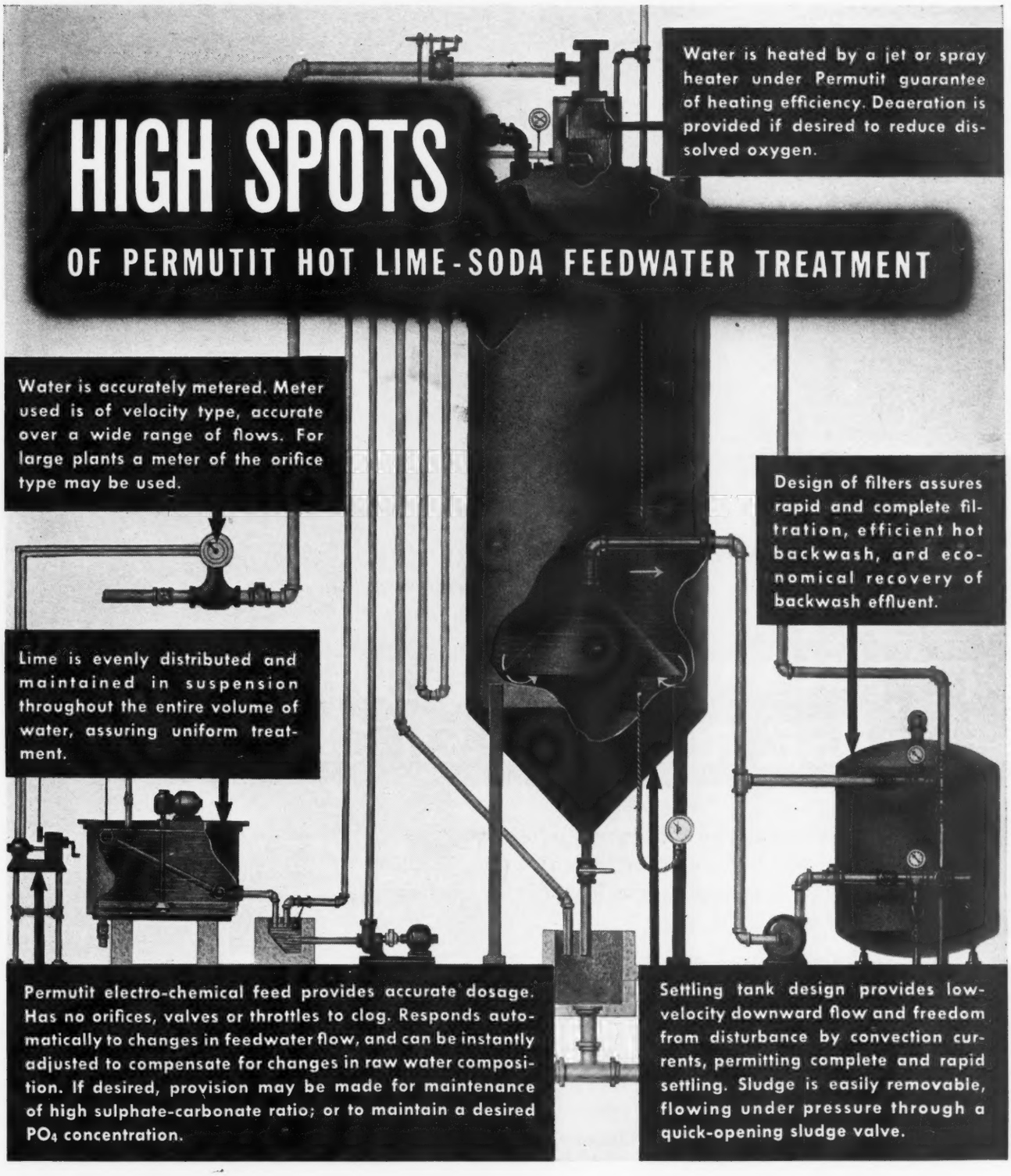
COME to Headquarters for the facts on Diesel engine starting. Let Exide recommend the type and size of battery for your equipment. This service is gladly supplied without cost.

THE ELECTRIC STORAGE BATTERY CO., Philadelphia
The World's Largest Manufacturers of Storage Batteries for Every Purpose
Exide Batteries of Canada, Limited, Toronto

Exide

BATTERIES

FOR STARTING DIESEL ENGINES


HIGH SPOTS
OF PERMUTIT HOT LIME-SODA FEEDWATER TREATMENT
Water is heated by a jet or spray heater under Permutit guarantee of heating efficiency. Deaeration is provided if desired to reduce dissolved oxygen.
Water is accurately metered. Meter used is of velocity type, accurate over a wide range of flows. For large plants a meter of the orifice type may be used.
Design of filters assures rapid and complete filtration, efficient hot backwash, and economical recovery of backwash effluent.
Lime is evenly distributed and maintained in suspension throughout the entire volume of water, assuring uniform treatment.
Permutit electro-chemical feed provides accurate dosage. Has no orifices, valves or throttles to clog. Responds automatically to changes in feedwater flow, and can be instantly adjusted to compensate for changes in raw water composition. If desired, provision may be made for maintenance of high sulphate-carbonate ratio; or to maintain a desired PO_4 concentration.
Settling tank design provides low-velocity downward flow and freedom from disturbance by convection currents, permitting complete and rapid settling. Sludge is easily removable, flowing under pressure through a quick-opening sludge valve.

PERMUTIT ENGINEERS will be glad to discuss possible application of this equipment to your plant. Your confidence in their counsel is warranted —by the fact that the Permutit organization is in a position to furnish equipment for all standard types of feedwater treatment. Write for the bulletin, "Permutit Hot Lime Soda Water Softening Equipment"; or ask for any special information you desire on any phase of water conditioning.

Permutit

Water Conditioning

The Permutit Company, Dept. A, 330 West 42nd St., New York, N. Y.

TO BALANCE SPEED AND POWER USE REX ROLLER CHAIN

● Here was a drive where the speed pointed to a certain pitch roller chain—but under analysis by a Rex Engineer, the load showed that in this case it would be an impractical application.

But working on the Rex application plan he was able to bring the speed and power requirements into balance. All the advantages of this positive economical drive were secured with a Rex Quadruple Roller Chain.

He had considered *all factors* and performance showed how right he had been. In applying power, similar opportunities still exist in practically every plant. The Chain Belt Company Application Service is always ready to consider your drive problems. In writing give r. p. m.'s of drive and driven shaft, and working load.

Waiting to be sent to you is a new book, "How to Handle IT," which shows some 40 typical examples of how Rex Chain and Rex Conveyors were used in twenty-odd industries.

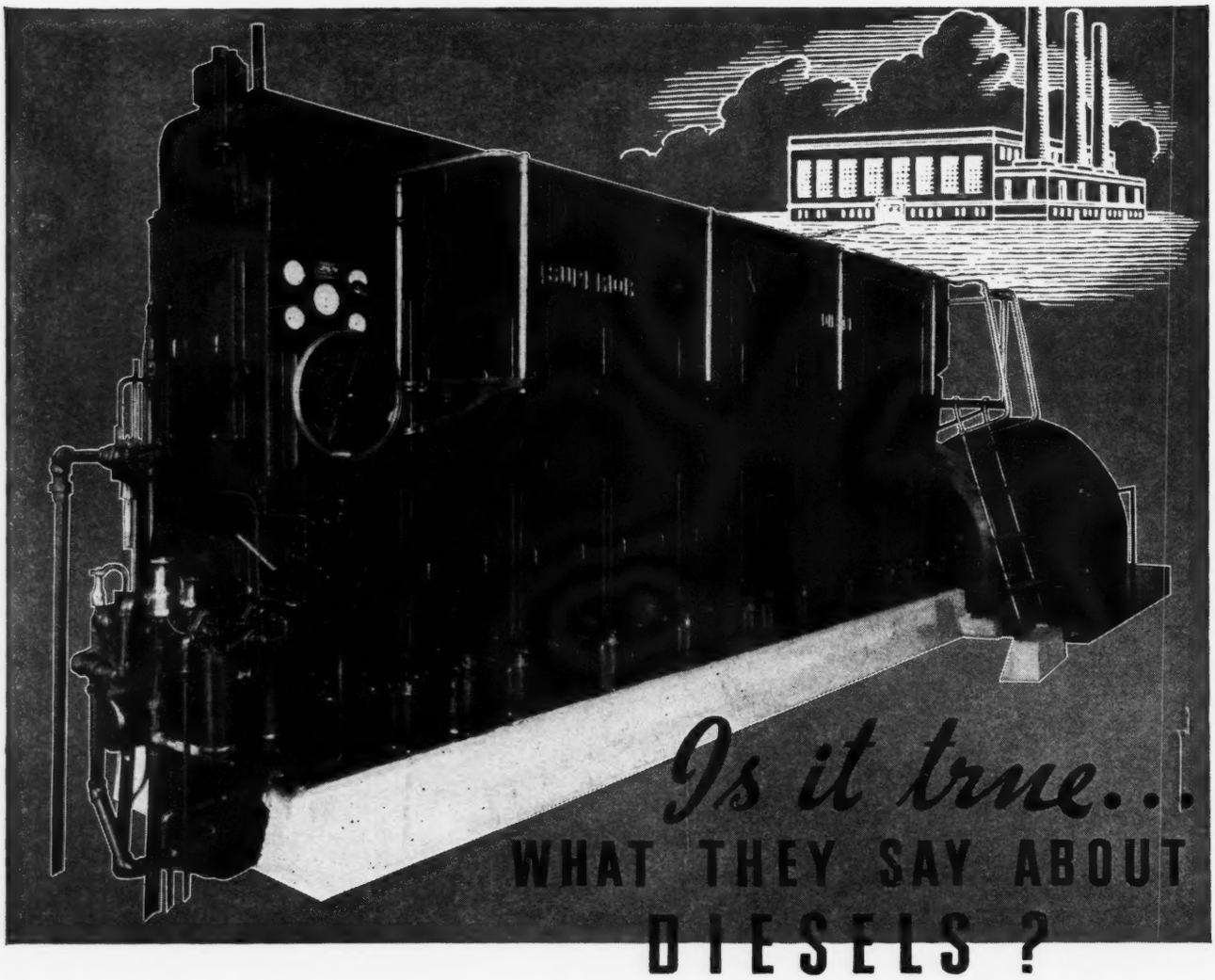
CHAIN BELT COMPANY
1674 W. Bruce St., Milwaukee, Wis.

REX

CHAIN BELT COMPANY
of MILWAUKEE

Drive and Conveyor Chains

HAGAN CONTROL
Does not all come
in the packing case
The Hagan Engineer with his knowledge of your combustion problem can not be confined within the walls of a packing case.
And it is his expert knowledge that counts. He knows your boiler like a book . . . he knows his control equipment and how to combine both so you will get results.
He lands on the job about the same time as the equipment to see that every part is properly installed. Then he stays with it until your engineers have had an opportunity to see what Hagan control actually means in action.
Hagan engineering service is the heart and soul of every Hagan installation.
HAGAN CORP., 300 ROSS ST. · PITTSBURGH
HAGAN CORPORATION AND SUBSIDIARIES . . .
HAGAN CORPORATION:—
Designers and installers of Combustion Control for Steam Boilers.
HALL LABORATORIES:—
Consulting, advisory and service organization of trained chemical engineers engaged in prescribing proper water treatment to maintain trouble free operation of steam boilers in industry.
BUROMIN CO.:—
Producers of a molecularly dehydrated phosphate developed by Hall Laboratories for boiler water conditioning.
The Pioneer Still Leads
IN SCIENTIFIC METHODS . . . IN MODERN EQUIPMENT



Is it true...

WHAT THEY SAY ABOUT DIESELS ?

The Sales Engineer of any well known Diesel engine manufacturer can tell you the truth about the DIESEL.

He will tell you that the Diesel is the most efficient prime mover known. He will tell you that the Diesel is the answer to many power problems and that the Diesel proves its reliability and operating economy by the millions of horsepower in service.

He will not tell you the Diesel is the answer to every power problem — or that one type of Diesel fits every need. He knows that steam or purchased power have their place too, and that it is to his best interest to recommend the most economical power for you — no matter who may sell it.

The Superior Engine Division of The National-Superior Company follows that policy, and because of 50 years of specialization in engine manufacture and application, is particularly well qualified to show you whether your plant can save with Diesel engines. The many types of Superior Diesels eliminate any compromise in selection.

* * * The alert power engineer will add Diesel knowledge to his mental equipment — he will want facts — he will study the cost-cutting possibilities and base his decision on logic, experience, and common sense, without riding any old or new hobbies.

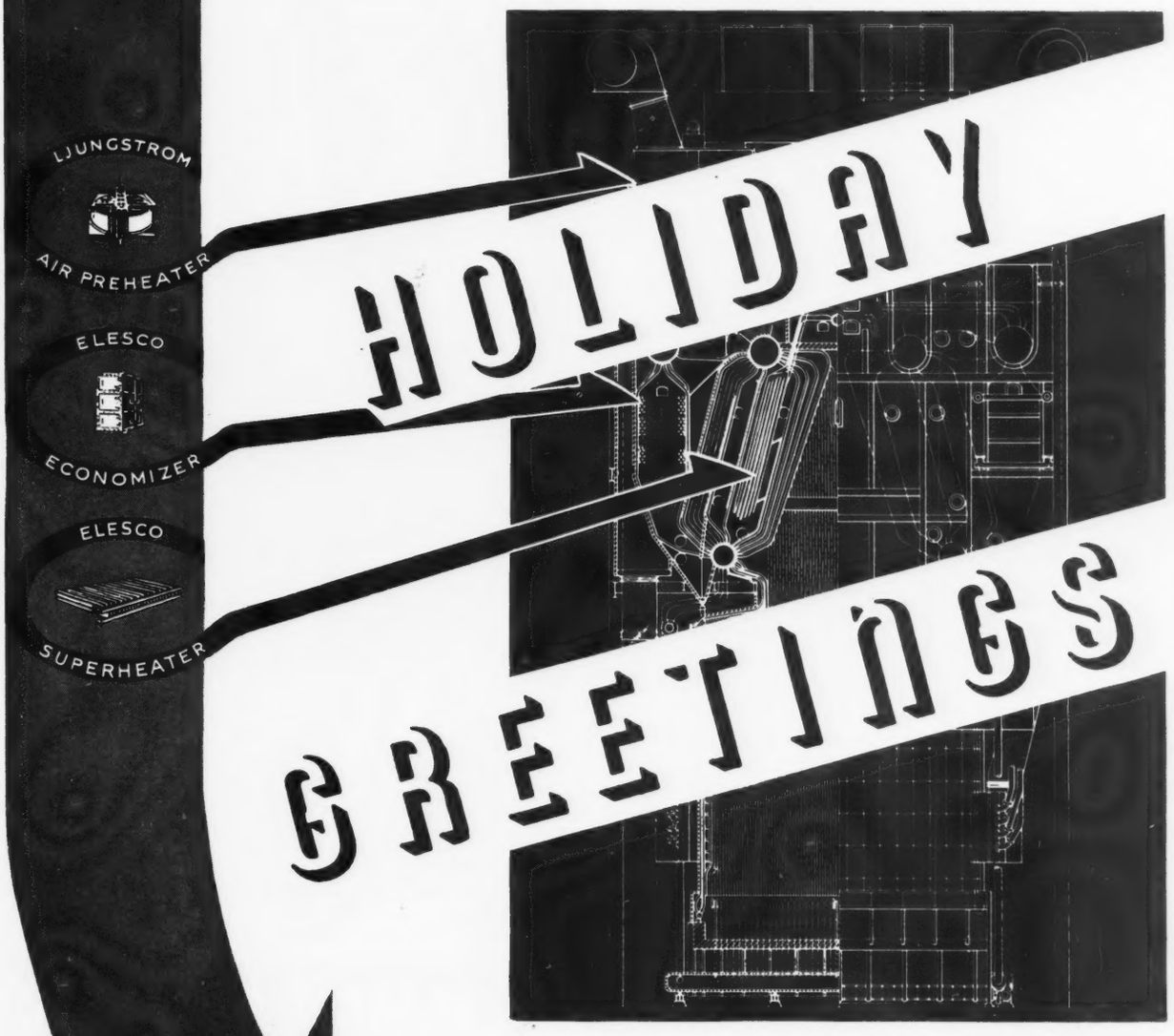
Will that type of power engineer invite our engineer to call? The National- Superior Company wishes to be of service, with no obligation implied.

***For the thought in this paragraph, we are indebted to POWER.

THE NATIONAL SUPPLY COMPANY OF DELAWARE
SUPERIOR ENGINE DIVISION
SPRINGFIELD, OHIO

Expansion . . . . . .

IN THE PLANT OF A LEADING *SOUTHERN* UTILITY STATION



ESSENTIAL COORDINATION PROVIDED BY ELESCOORDINATED SUPERHEATERS, ECONOMIZERS, AIR PREHEATERS . . . . . AND ELESCO BIFURCATED WATER WALLS

Steam Temperature . . . . . 925° F

Water Temperature . . . . . 516° F

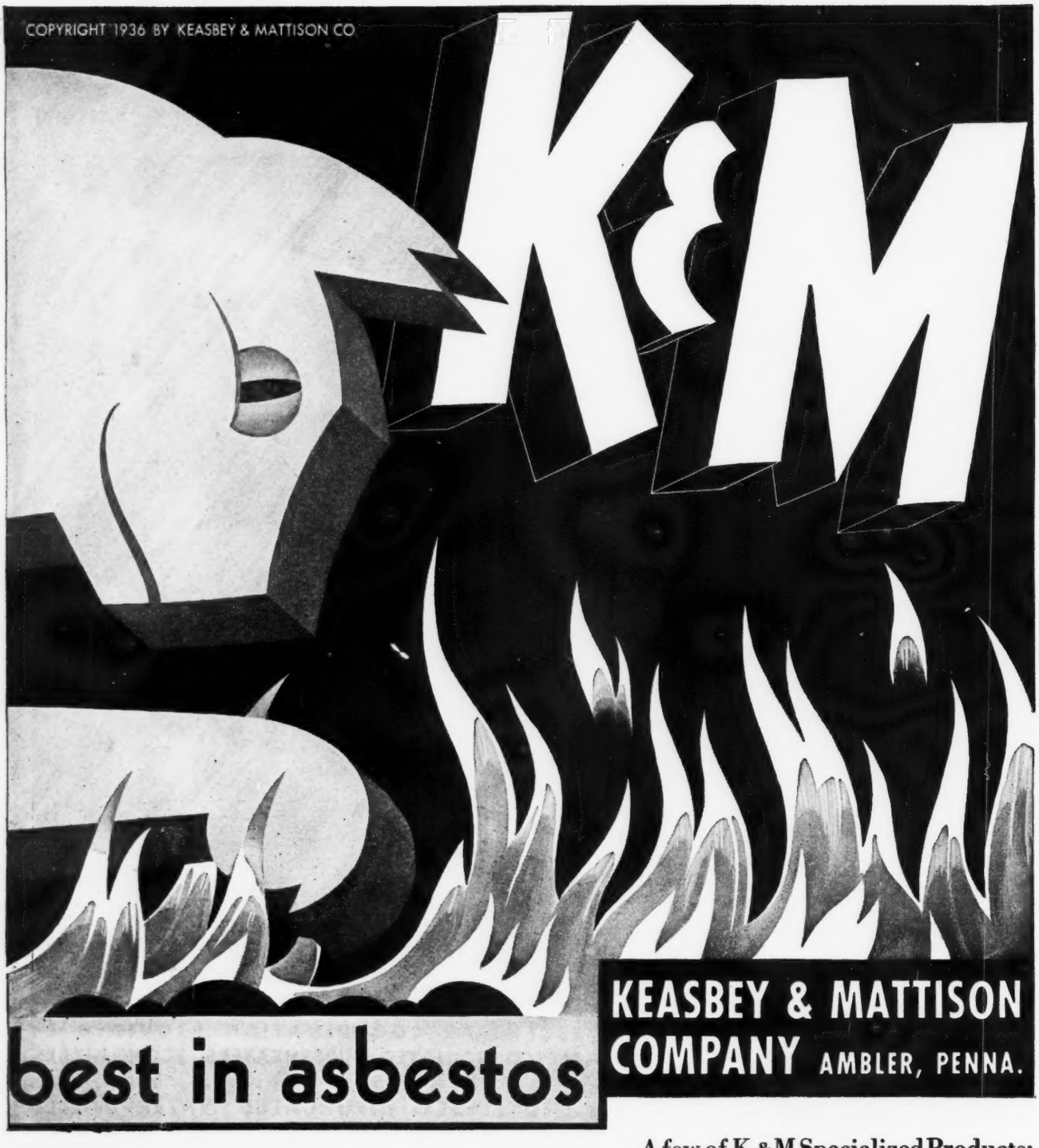
Air Temperature . . . . . 549° F

Capacity (Maximum) per Hour . . 1,000,000 lb.

ELESCO ORDINATED

ELESCO SUPERHEATER · ELESCO ECONOMIZER · LJUNGSTROM AIR PREHEATER

Copyright 1936 • The Superheater Company • 60 East 42nd St., New York

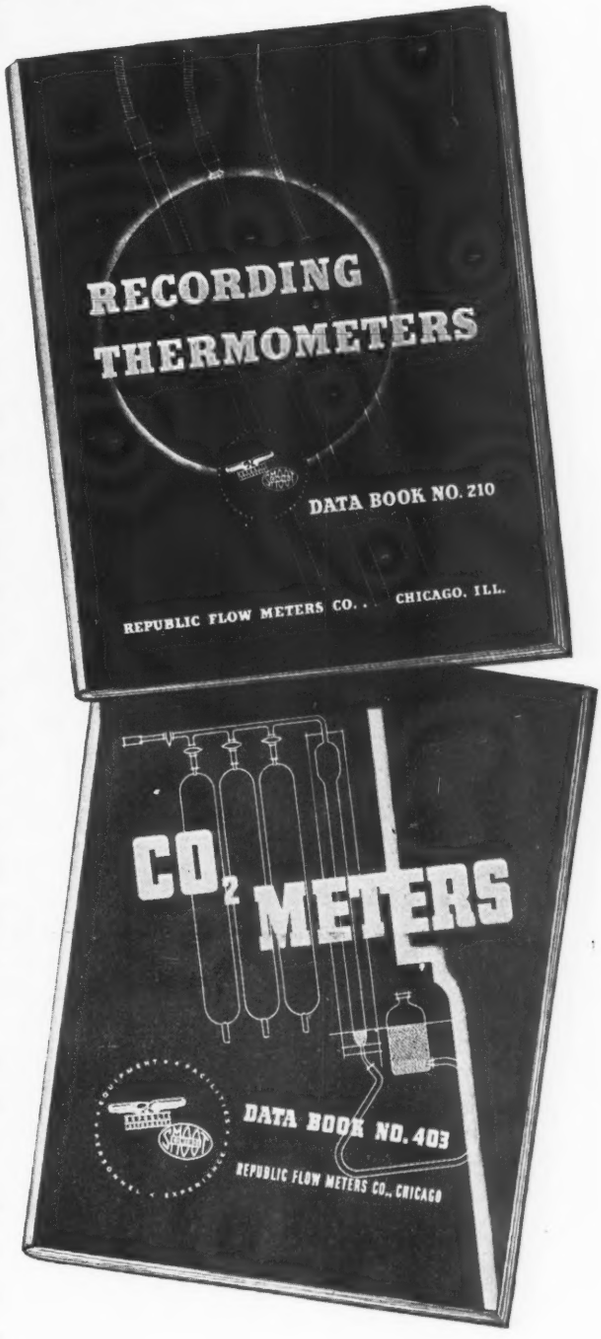


Economy may be your chief reason for using K & M Asbestos and Magnesia products. Their uniformity and durability may appeal most to you. K & M products are the perfected result of a rigid quality-control that starts with the raw asbestos fiber . . . their leadership rests upon more than 60 years spent in the development of insulation materials.

A few of K & M Specialized Products:

"Featherweight" 85% Magnesia
Pipe Insulation, Blocks and Lagging
Asbestos Pipe Insulation in sections
Asbestos Insulation in sheets and blocks
Asbestos Insulating Cements
Asbestos Packings: rope, cord and sheet
Asbestos Gaskets, Gasket Tapes and Cloth
Welding Electrodes (Celto)
Refractory Cements, dry and plastic
Asbestos Cement Sheets
in corrugated and flat form

2 NEW DATA BOOKS



DATA BOOK No. 210: Describes and illustrates a new and outstanding development in recording thermometer design and construction. The helical spring is sealed in a metal cartridge which can be easily removed from the instrument without exposing any mechanism or disturbing the instrument mounting. This feature makes for lower maintenance cost, ease of operation and a minimum of service interruptions.

DATA BOOK No. 403: Presents informative data of value to every engineer interested in obtaining efficient combustion. It is well illustrated and contains a complete description of the Republic CO_2 meter which registers a continuous pen line record of per cent CO_2 in the flue gas, measured by the accurate and dependable Orsat method (volumetric-absorption).

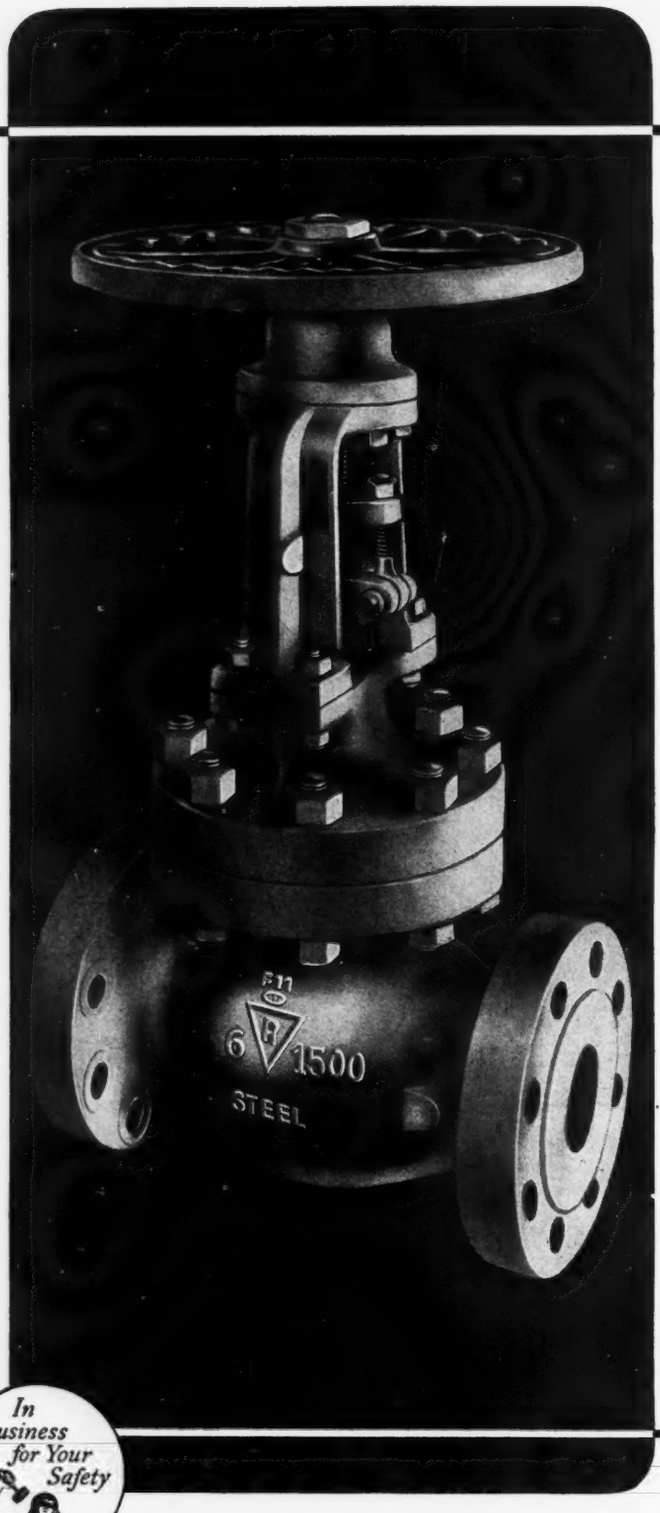
Write for either or both of these Data Books—you will find them of unusual interest. We will gladly mail them upon request without obligation.

The Republic Flow Meters Co. is in a position to help you solve any metering or control problem up to the point of taking undivided responsibility for the entire job. We invite power and consulting engineers to investigate this service.

EQUIPMENT • • FACILITIES • PERSONNEL • EXPERIENCE •
REPUBLIC INSTRUMENTS SMOOT CONTROL

REPUBLIC FLOW METERS CO.

2222 DIVERSEY PARKWAY · · · CHICAGO, ILLINOIS



STEEL VALVES

•

Built to specific service requirements

Reading steel valves are made of the steel and the trim materials selected to give the best service for the particular conditions on which they are used.

Whether resistance to corrosion, pressure or temperature are factors for consideration, there's a Reading Steel Valve that will more than meet requirements. For the exacting demands which exist in steam plants, refineries, pipe lines or other projects where service conditions are unusually severe, Reading Valves are particularly suitable.

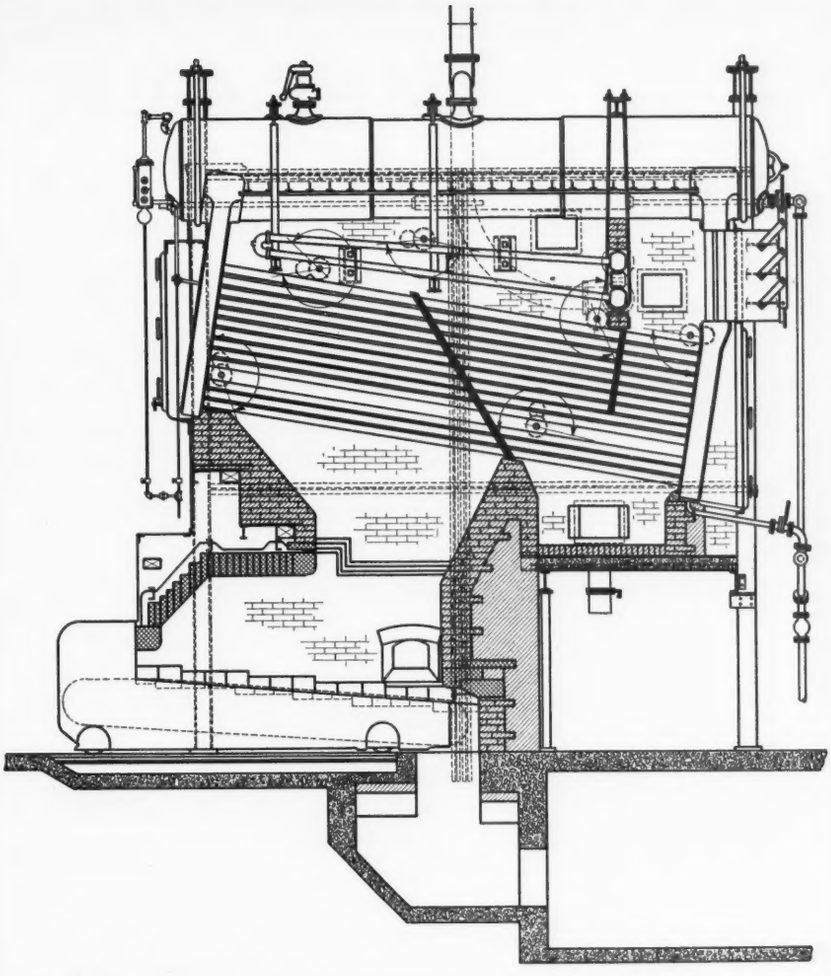
If your service demands steel valves and fittings . . . consult Reading-Pratt & Cady—they show you a valve built to your particular requirements.

READING-PRATT & CADY COMPANY, Inc.

An Associate Company of the American Chain Co., Inc.

Bridgeport, Connecticut

READING—PRATT & CADY VALVES



MURRAY Type "A" Water Tube BOILERS

Assure:

1. Economy of **FUEL CONSUMPTION.**
2. Successful operation at **200** and **300% CONTINUOUS RATING,** and **WELL OVER 400% RATING FOR LONG OVERLOAD PERIODS.**
3. **THE GREATEST STEAM RELEASING AREA** possible in water tube boilers.
4. **DRY STEAM UNDER ALL LOAD CONDITIONS.**
5. **STRUCTURAL FLEXIBILITY** that entirely eliminates danger of leaks under any operating condition.
6. **EASE** of cleaning and maintenance.

66 years successful experience in building steam power equipment.

MURRAY IRON WORKS COMPANY

BURLINGTON, IOWA

MURRAY

"MEG"
Insulation Tester
500 volt generator
100 megohm range
Weight 6¾ lb.
Turn the crank and read the scale.

"MEGGER"

TRADE MARK REGISTERED U.S. PAT. OFF.

INSURANCE

"Saved Its Cost Many Times"

"From 1927 to 1934 our plant was idle and absolutely nothing was done toward electrical maintenance. . . . Upon being given the job of getting ready to operate the season of 1934 . . . we bought one of your 'Meggers' and I can truly say the cost has been saved many times over, especially during that period of renovation, when the wrong 'guess' concerning a certain piece of equipment, would have meant more than the cost of the 'Megger'."—*From the Chief Electrician of a large western sugar company.*

It is good ***insurance*** to make "Megger" tests, not only after periods of idleness, but ***during operation,*** so as to avoid unexpected breakdown. Write for descriptive "Megger" Catalog 1400-P.

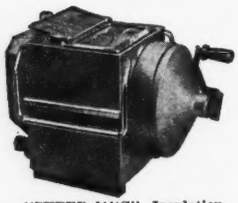
JAMES G. BIDDLE CO.

ELECTRICAL INSTRUMENTS

1211-13 ARCH STREET PHILADELPHIA, PA.

"MEGGER" Testing Set

"BRIDGE-MEG" Resistance Tester



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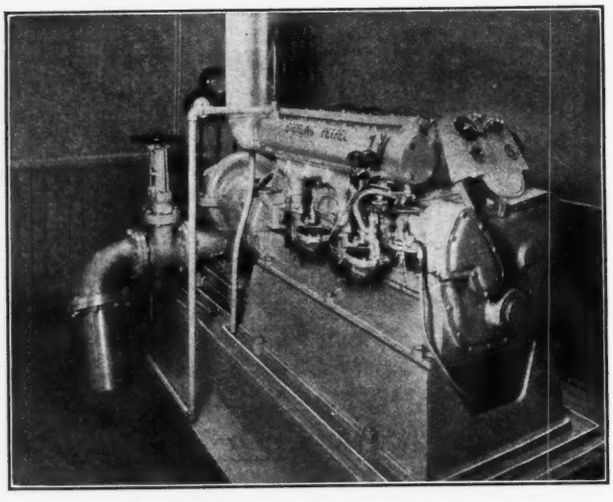

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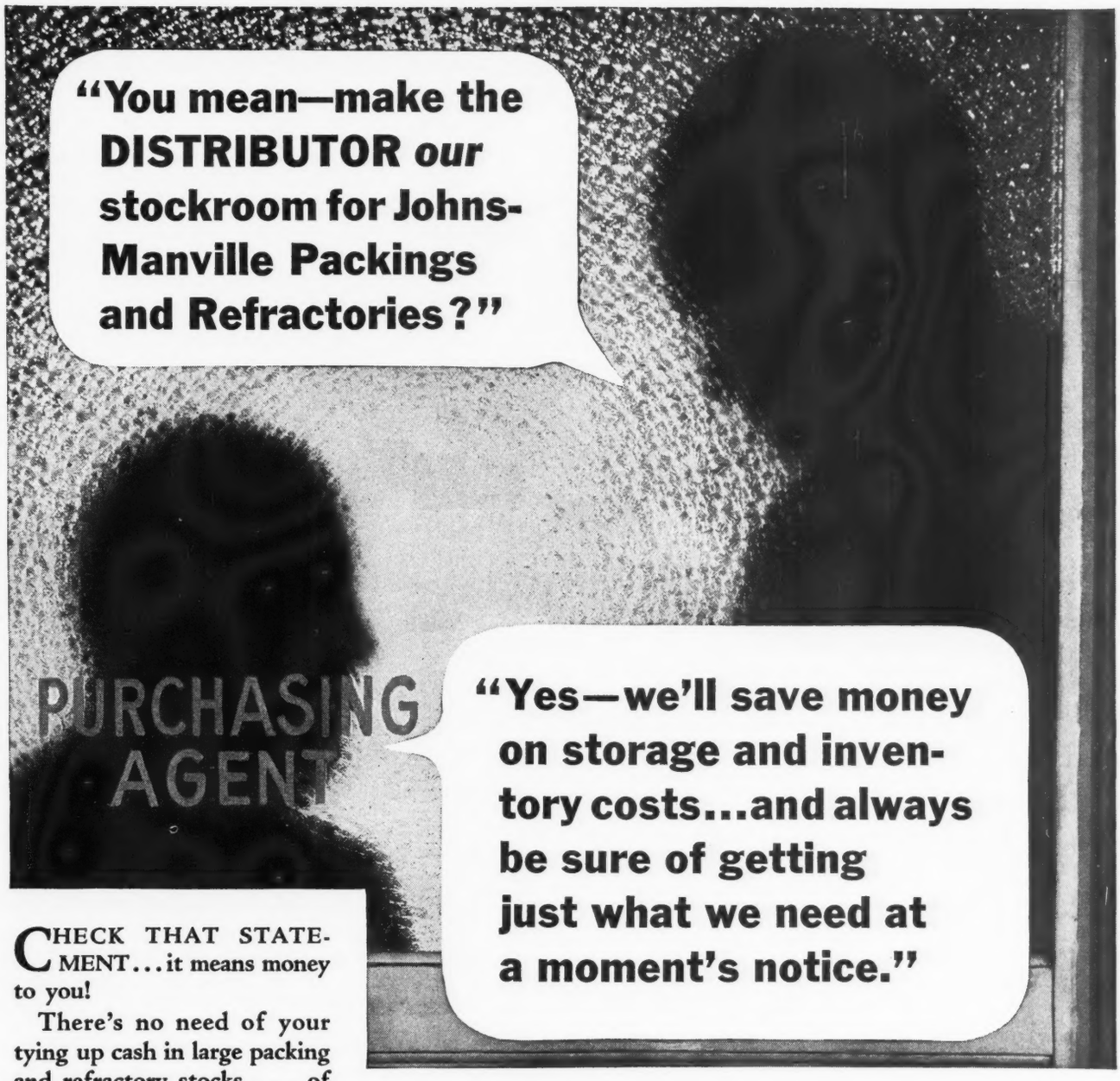
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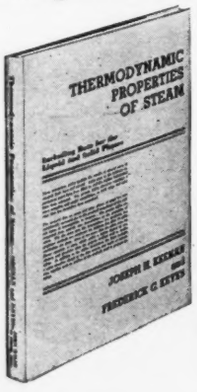

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The Contents

Introduction
Bibliography
Symbols Used in Tables
Saturation: Temperatures
Saturation: Pressures
Superheated Vapor
Compressed Liquid
Saturation: Solid-Vapor
Viscosity
Heat Conductivity
Conversion Factors
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P 12-36

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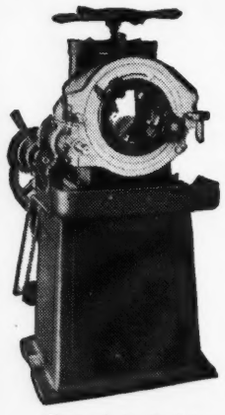

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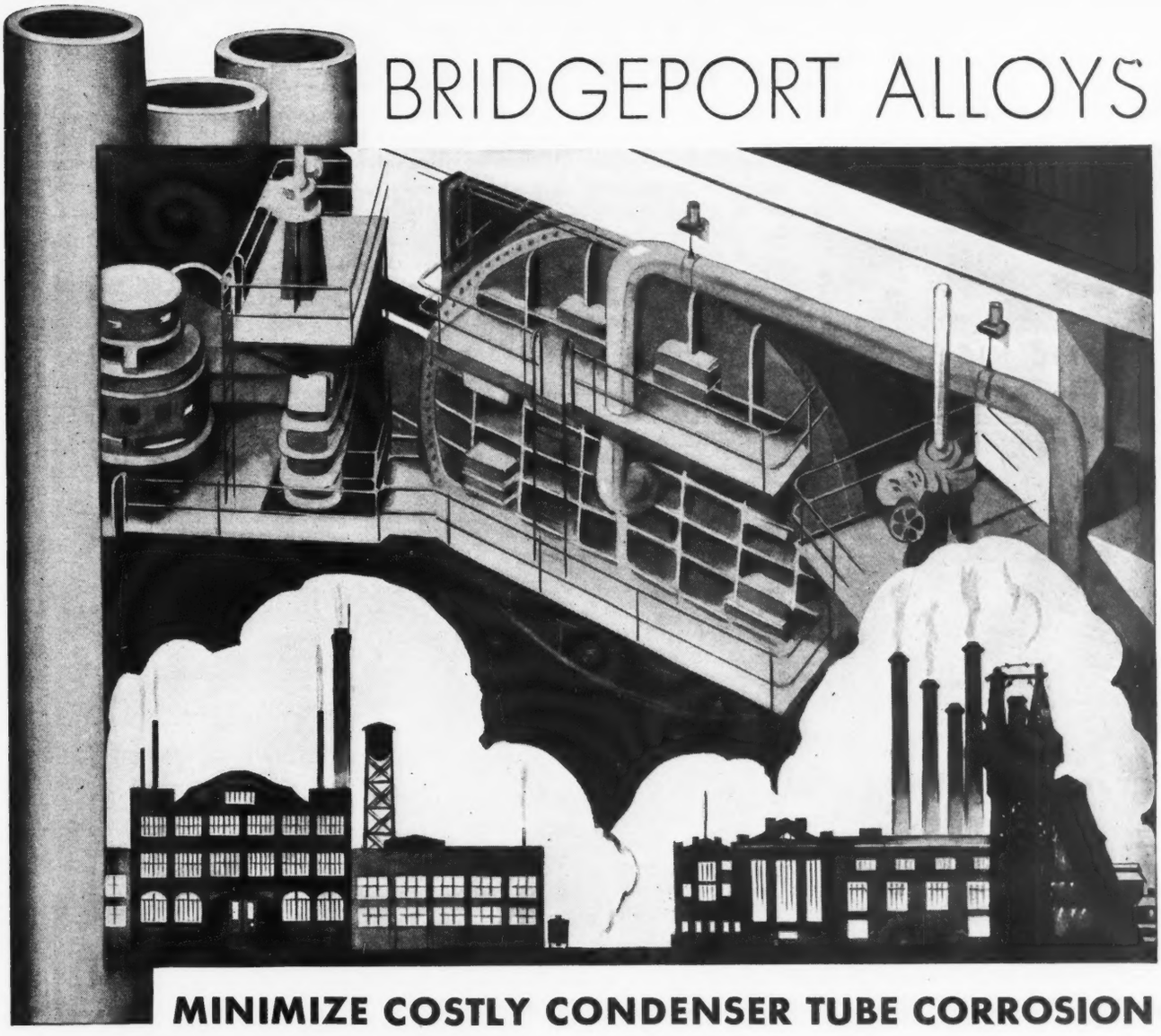

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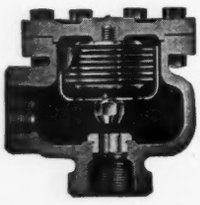

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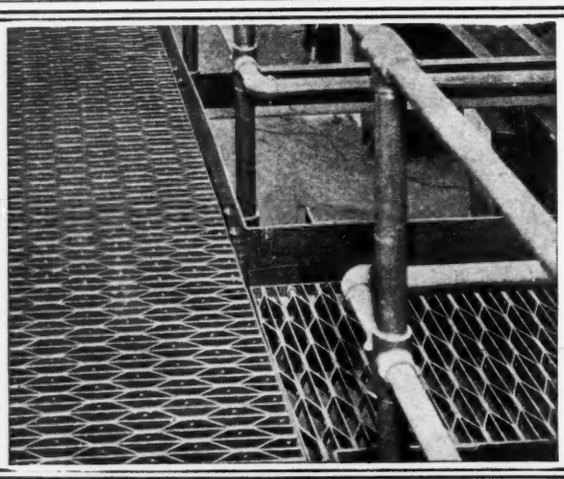

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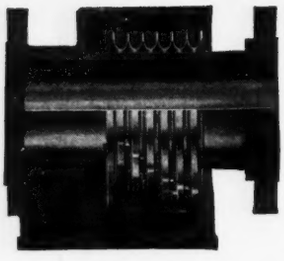

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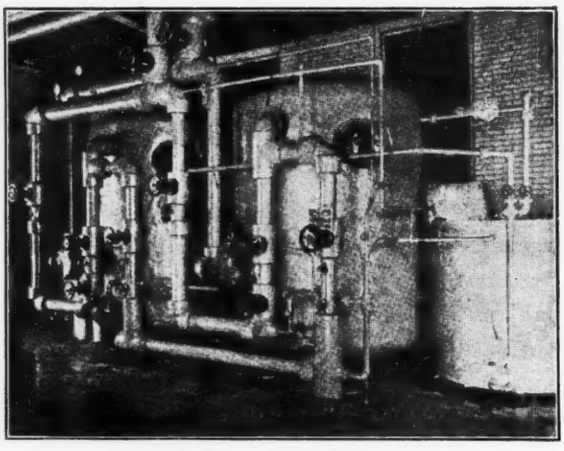

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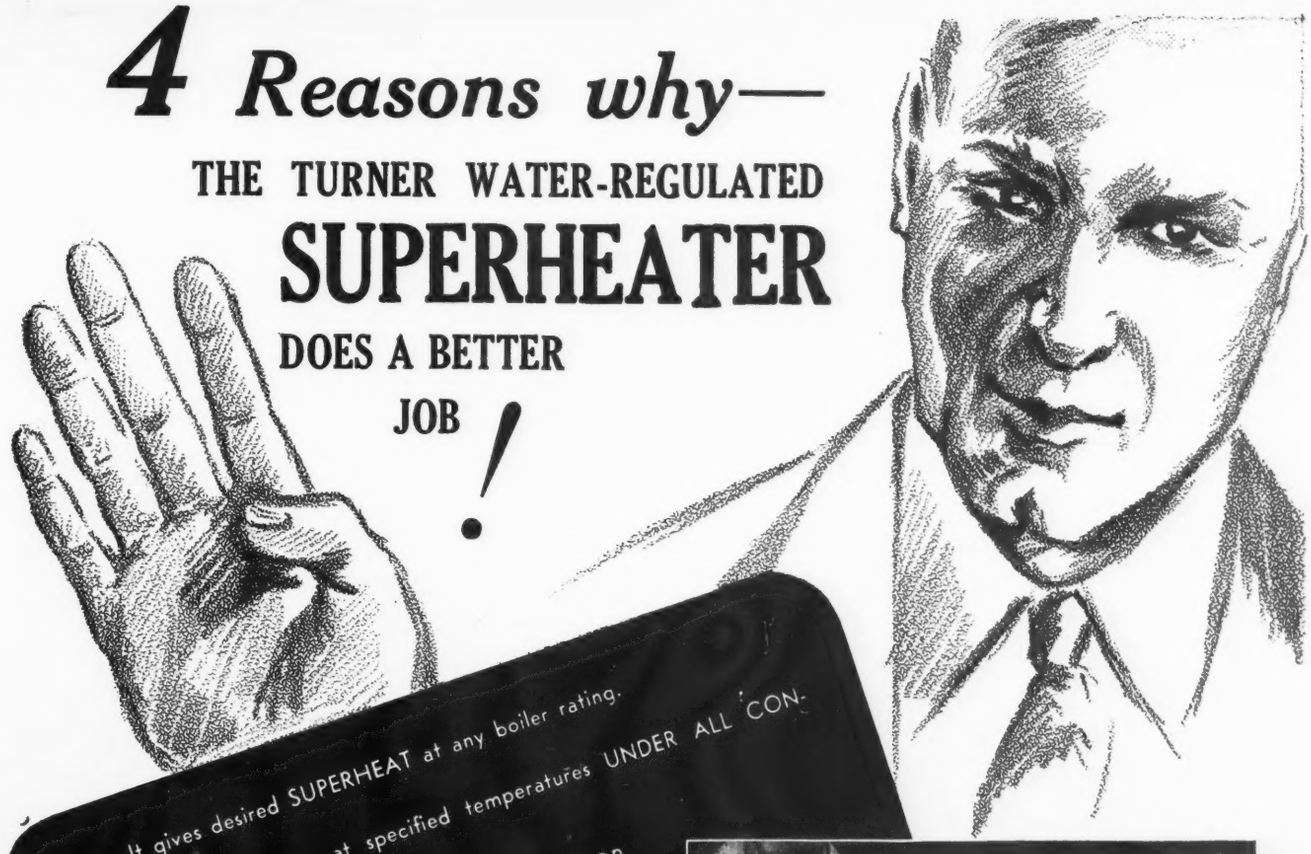

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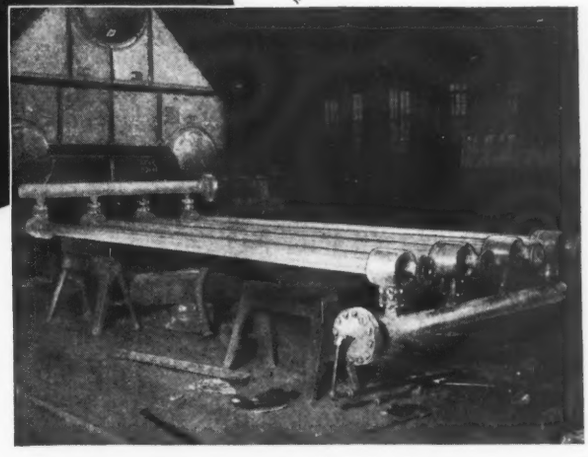

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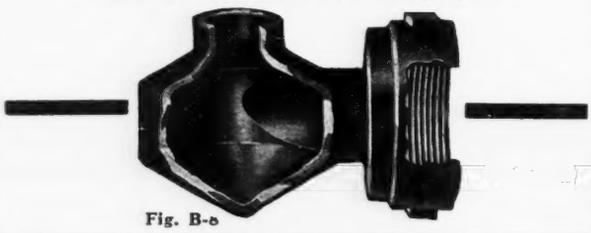

Fig. B-8

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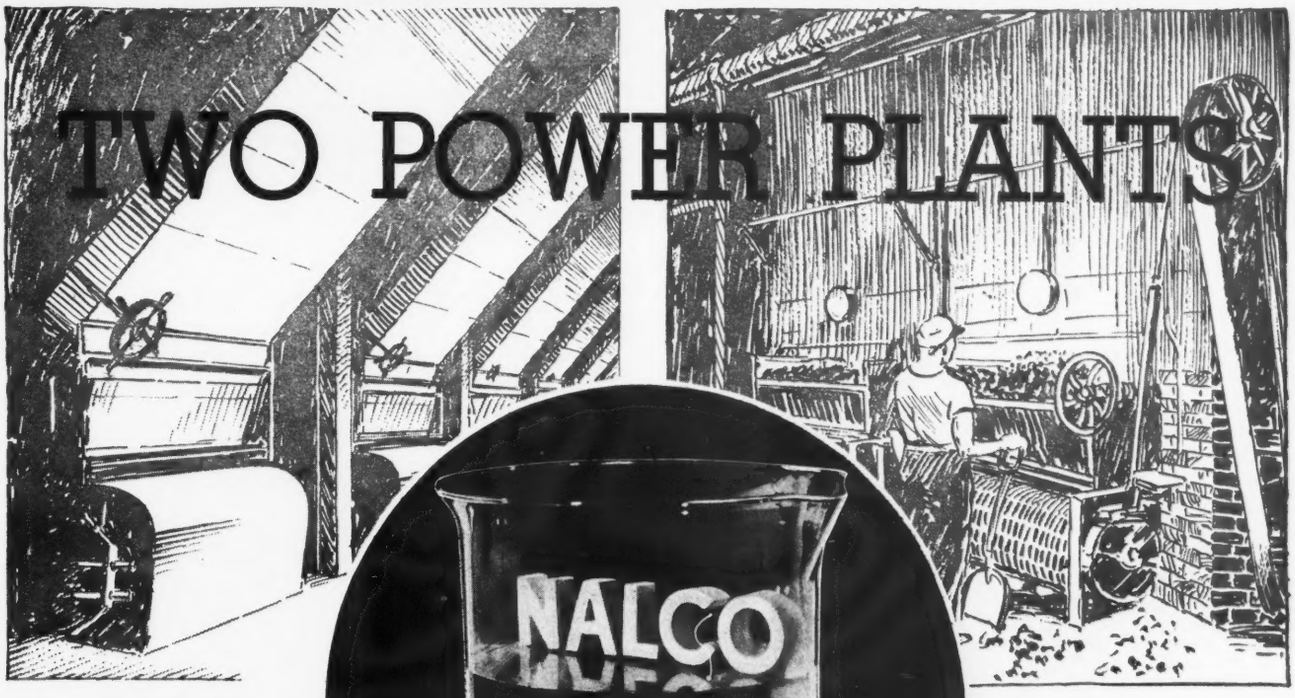

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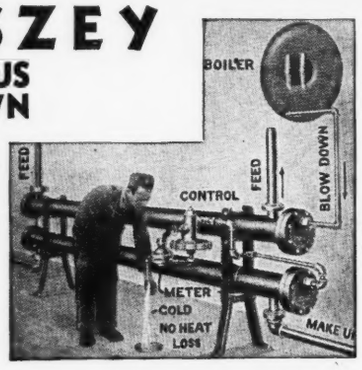

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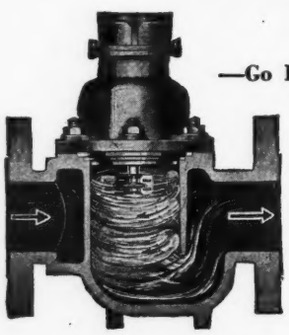

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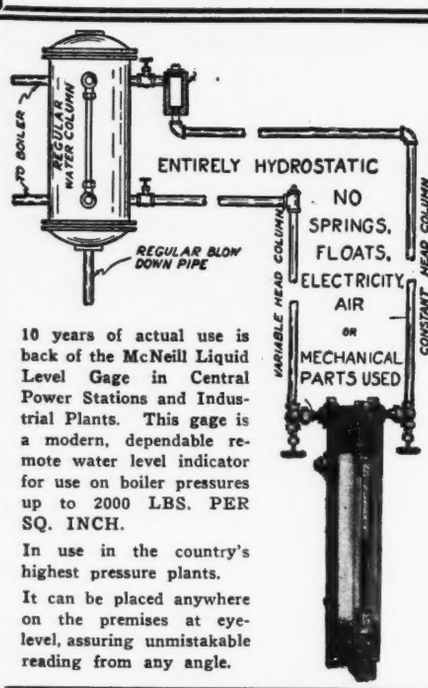

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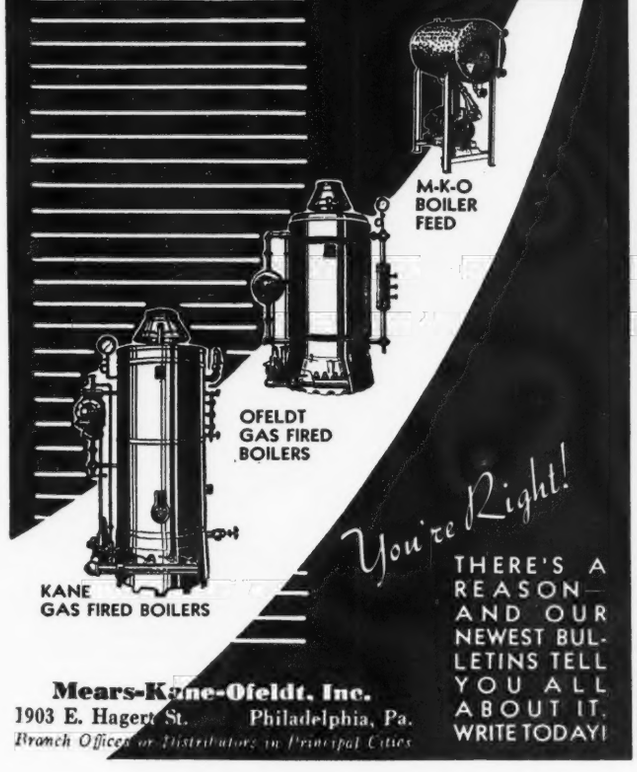

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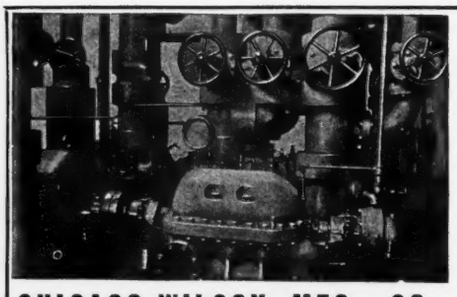

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NAUGATUCK MFG CO.

460 North Main St., Naugatuck, Conn.

Find what you are looking for? If this or other advertising in this issue does not supply the information wanted, of products or services, write

Power
330 West 42nd Street, New York City

PROFESSIONAL SERVICES

OLIVER FIELD ALLEN

Licensed Professional Engineer New York State
Fellow: A.I.E.E. Member: A.S.M.E., S.A.E.
Am. Chem. Soc., Am. Mil. Engrs.
Consulting Engineer
Diesel Engines. International Engineering Liaison.
Gas and Oil Engine Power Applications.
Regular Foreign Correspondents.
117 Liberty Street, New York City
Cable Address: OFALL-New York

W. E. S. DYER

CONSULTING ENGINEER
Power Plants, Industrial Buildings, Packing Houses, Refrigeration, Tests, Reports, Appraisals, Designs and Supervision.
Special Processes and Devices
11th Floor—21 West Street, Battery Park, New York City

HALL LABORATORIES, Inc.

R. E. Hall, Ph.D., Director
CONSULTANTS ON
BOILER WATER CONDITIONING
304 Ross St. Pittsburgh, Pa.

Usually it pays large dividends to call in a consultant with his valuable outside viewpoint, backed by his knowledge and broad experience, to check with you before making final decisions regarding your product.

SARGENT & LUNDY

INCORPORATED
ENGINEERS
140 SOUTH DEARBORN ST.
CHICAGO, ILLINOIS

FRANCIS J. SILL

HEAT and POWER ENGINEERING
as applied to Industrial Plants
Tests—Reports—Design—Construction
Westboro, Massachusetts

JOHN A. STEVENS, Inc.

Established 1909
CONSULTING ENGINEERS
Power Plants Paper Mills
Dye Houses Surveys
Lowell, Massachusetts

THE J. G. WHITE ENGINEERING CORPORATION

ENGINEERS—CONSTRUCTORS
Plant Designs and Construction
Investigations and Studies of Power Problems and Costs
80 Broad St., New York

POWER

SERVICE SECTION

Machinery, Material, Equipment and Supplies for Power Plants

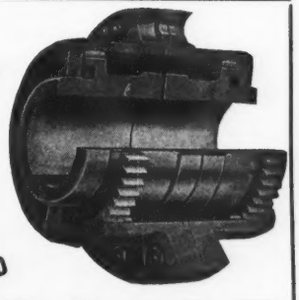
NICHOLSON

WELDED STEEL FLOATS
CHROMIUM PLATED
AND
STAINLESS STEEL FLOATS

Good for pressures up to 2,000 lbs. Round sizes 3" to 12" in stock. Write for Bulletin No. 431. Inquiries on special floats solicited.

W. H. NICHOLSON & COMPANY
125 Oregon Street, Wilkes-Barre, Penna.

ALL-METAL
SELF
ALIGNING
DUST-
PROOF
OIL-TIGHT
LUBRICATED



POOLE

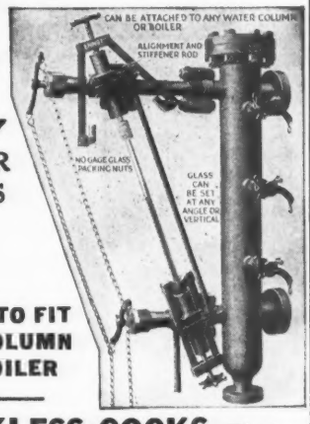
Flexible Couplings

Send for our coupling catalog P-36, describing our full line of flexible couplings

Poole Foundry & Machine Co.
Woodberry, Baltimore, Md.

SPECIFY For Any Pressure
SPLIT-GLAND

Inclined
or
Vertical


CAN BE ATTACHED TO ANY WATER COLUMN OR BOILER
ALIGNMENT AND STIFFENER ROD
NO GAGE GLASS PACKING NUTS
GLASS CAN BE SET AT ANY ANGLE OR VERTICAL

WATER
GAGES

MADE TO FIT ANY COLUMN OR BOILER

LEAKLESS-COCKS

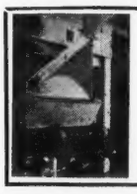
Write for Catalog "P"

ERNST WATER COLUMN & GAGE CO.
Offices in Principal Cities NEWARK, N. J.

THE ORIGINAL
Tripp Metallic Packing
TRIPP METALLIC PACKING CO.
BOSTON MASS.

COAL *HANDLED FROM CAR TO BOILER*—3c TO 7c A TON
Power plants should investigate this source of cutting costs

With Godfrey Monorail System (illustrated) coal flows from drop-bottom cars through track chute into conveying bucket. Bucket is then raised and conveyed to storage bin and contents automatically discharged. Coal flows by gravity into boiler room or stoker as needed. Easily regulated—one man controls entire operation.
Let us make a cost and saving analysis of your problem. No obligation. Write for our catalog.
GODFREY CONVEYOR CO., 13th Street Elkhart, Ind.

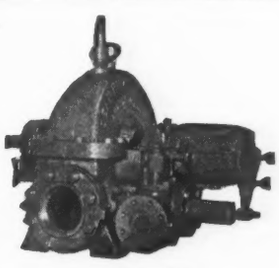


Eliminate Segregation with
CONICAL
Non-Segregating
Coal Distributors
STOCK ENGINEERING CO.
438 Penton Bldg., Cleveland, Ohio

"MONO"
BOILER BAFFLES
HIGH TEMP. REFRACTORY CEMENTS
SANFORD C. SMITH REFRACTORIES, INC.
1715 Niagara St., Buffalo, N. Y.

CORRECT SPEEDS WITH GS TACHOMETERS
GEO. SCHERR CO.
426 LAFAYETTE ST. N.Y.

O-Z IMPROVED TACHOMETERS
with
FIXED READING DEVICE
Read Speeds at leisure: R.P.M., F.P.M. Also Speed Fluctuations. Send for catalog.
O. ZERNICKOW CO.
21 Park Row New York

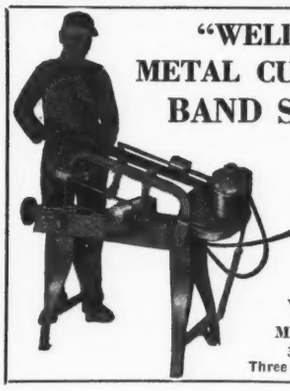


Type D
MECHANICAL DRIVE STEAM TURBINES
1 to 400 H.P.
RELIABLE EFFICIENT
DEAN HILL PUMP CO.
ANDERSON, IND.
STEAM TURBINES
PUMPING MACHINERY

The Mark of Quality

ALBANY GREASE
The Tallow Compound
Used by Engineers and Mechanics since 1838
ALL LUBRICANT—NO DRIP
NO WASTE
For literature and prices write
Adam Cook's Sons, Inc., Linden, N.J.

"WELLS"
METAL CUTTING BAND SAWS



No. 5 Capacity 5" Round 5"x10" Flat
No. 8 Capacity 8" Round 8"x16" Flat

WELLS
MFG. CORP.
315 7th Ave.
Three Rivers, Mich.

SPEED RECORDERS
HASLER TEL
ALSO SPEEDOMETERS WITH "RUNNING TIME" COUNTERS
R.W. Cramer & Co. 67 Irving Place, New York, N.Y.

ADVERTISING GIVES SALESMEN—

SEVEN LEAGUE BOOTS

TO outstrip competitors in today's race for sales, let advertising win the attention of the prospect, create the desire to buy, and establish preference for the product. With these things done by advertising, your salesman can start on the actual work of closing the sale.

It's highly questionable whether you *can* meet competition if high-priced flesh-and-blood salesmen do the penny-a-call work that advertising can do as well. Can you afford to make your salesmen devote their time to doing the work which advertising can do at a fraction of the cost?

McGRAW-HILL PUBLICATIONS

McGraw-Hill Publishing Company, Inc., 330 West 42nd Street, New York, N. Y.

American Machinist
Aviation
Bus Transportation
Business Week
Coal Age
Chemical and Metallurgical Engineering
Construction Methods
Electrical Contracting
Electrical Merchandising
Electrical West
Electrical Wholesaling
Electrical World
Electronics
Engineering and Mining Journal
Engineering News-Record
Factory Management and Maintenance
Food Industries
Metal and Mineral Markets
Mill Supplies
Power
Product Engineering
Radio Retailing
Textile World
Transit Journal

Here's HOW TO SAVE FRICTION LOSSES!

Cut mechanical power transmission losses with Medart Timken Pillow Blocks, Hanger Bearings, Flange Units and Unit Mounts... Smooth, anti-friction operation... Easy to install—easy to remove—no attention required after installation except occasional lubrication ... Sealed against leakage of lubricant—dirt cannot enter the housing. Completely assembled and lubricated before shipment.

Furnished in 4 types: For General Purpose Applications... For High Speeds and Shock Loads ...For Conveyor and Machinery Applications... For Light Duty General Purpose Applications.

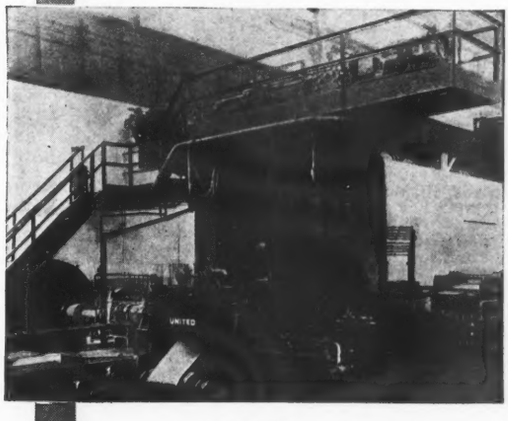
●

GET VALUABLE ENGINEERING CATALOGS

Send for new Medart Engineering Reference Catalogs! 56T "General Mechanical Power Transmission Equipment"—144 pages... 56G "Gears"—80 pages... 56V "V-Belt Drives"—44 pages... Convenient for filing and quick reference — size 8½"x 11"... Contain valuable engineering and estimating data—handy for everyday use.

MEDART-TIMKEN BEARING UNITS

This Medart-Timken self-aligning, non-expansion unit is adaptable to all requirements calling for the use of an individual anti-friction mounting.



LARGEST EVER INSTALLED

This four-high, cold-strip mill is equipped with Medart Roller-Bearing Pillow-Block Pedestals with Timken Bearings — shaft size approximately 12" diameter, the largest ever installed.

MEDART

THE MEDART COMPANY

Gen. Offices & Works: 3516 DeKalb, St. Louis, Mo.

Engineering Sales Offices: Cincinnati • Cleveland New York • Philadelphia • Buffalo • New Orleans Chicago • Birmingham • San Francisco • Los Angeles Dallas • Denver • Charlotte • Pittsburgh • Milwaukee

SEARCHLIGHT SECTION

EMPLOYMENT : BUSINESS : OPPORTUNITIES : EQUIPMENT—USED or RESALE

UNDISPLAYED—RATE PER WORD

Positions Wanted (full or part-time salaried employment only), 5 cents a word, minimum $1.00 an insertion, payable in advance. *(See ¶ on Box Numbers)*

Positions Vacant and all other classifications 10 cents a word, minimum charge $2.00.

Proposals, 50 cents a line an insertion.

INFORMATION:

Box Numbers in care of our New York, Chicago and San Francisco offices count 10 words additional in undisplayed ads.

Discount of 10% if full payment is made in advance for four consecutive insertions of undisplayed ads (not including proposals).

DISPLAYED—RATE PER INCH:

1 inch $6.00
2 to 3 inches..... 5.75 an inch
4 to 7 inches..... 5.50 an inch

Other spaces and contract rates on request.

An advertising inch is measured vertically on one column, 3 columns—30 inches—to a page.

P

EMPLOYMENT SERVICE

SALARIED POSITIONS, $2,500 to $25,000. This thoroughly organized advertising service of 27 years' recognized standing and reputation carries on preliminary negotiations for positions of the caliber indicated through a procedure individualized to each client's personal requirements. Several weeks are required to negotiate and each individual must finance the moderate cost of his own campaign. Retaining fee protected by a refund provision as stipulated in our agreement. Identity is covered and, if employed, present position protected. If you have actually earned over $2,500, send only name and address for details. R. W. Bixby, Inc., 270 Delward Bldg., Buffalo, N. Y. (P.)

AUDELS ENGINEERS & MECHANICS GUIDES

Practical educators for all Engineers, Firemen, Machinists, Electricians and engineer students. Eight valuable, up-to-date Guides treating on the theory and practice of modern Engineering in all its branches.

A COMPLETE HOME STUDY COURSE AND REFERENCE LIBRARY

$1 PER MO.

8 pocket numbers with Ready Reference Index 8734 pages. 4750 illustrations. Easy to read. Highly endorsed. A good help in securing Engineer's License. Price $12; terms, $1 per month. Free Trial.

INFORMATION: — *In A Handy Form.* Answers to Your Questions and Problems. Here is a partial list of the subjects covered:— **Engine Principles, Valve Setting, Pumps, Corliss Engines, Uniflow Engines, Pumping Engines, Contractors Engines, Locomotives, Marine Engines, Turbine Engines, Gas Engines, Oil Engines, Indicators, Producers, Aviation, Steam, Fuel Economy, Boiler Construction, Firing, Oil Burners, Stokers, Boiler Repairs, Pipe Fitting, Heating, Refrigeration, Elevators, Dynamos, Motors, Lighting, Wiring, Electrical Diagrams, Radio, Electrical Reference and Calculations.**

SHIPPED FREE

Not a cent to pay until you see the books. No obligation to buy unless you are satisfied Fill in coupon *in pencil*. Send now—today—get this standard library for Engineers and Mechanics.

FREE EXAMINATION COUPON

Theo. Audel & Co., 49 W. 23 St, N.Y. City
Send me AUDELS ENGINEERS AND MECHANICS GUIDES 8 numbers, $12, for *free examination*. If satisfactory, I will send you $1 in 7 days, then $1 monthly until $12 is paid.

Name.....
Address.....
Occupation.....
Employed by..... Power

POSITION WANTED

COMBUSTION ENGINEER. 18 years' experience in power plant practice. Can manage plant and personnel efficiently. PW-644, Power, 520 No. Michigan Ave., Chicago, Ill.

SELLING OPPORTUNITIES

OFFERED—WANTED

Selling Agencies—Sales Executives
Salesmen—Additional Lines

OPPORTUNITY WANTED

DAILY REPORT on new business available in 48 states. Construction projects, industrial and commercial buildings, public works, all types of civil engineering construction reported in proposed, bids asked, and contracts awarded stages. Mailed daily by first class or air mail. $10 per month, $1 additional for air mail. Speeds up sales follow up. Write for sample, McGRAW-HILL CONSTRUCTION DAILY, 330 W. 42nd St., New York, N. Y.

OPPORTUNITY FOR INDUSTRIAL SALES ENGINEERS

We have immediate openings for several experienced industrial sales engineers. Direct Factory connection, salary, bonus, and expenses. Only men with engineering background and proven sales records considered. Car essential. Experience in combustion equipment decided advantage. Send full details of your qualifications, enclosing recent photograph.

Iron Fireman Manufacturing Co.
3170 West 106th Street, Cleveland, Ohio

SALES ENGINEERS

Districts available for the sale of outstanding lines of Underfeed and Overfeed Stokers manufactured by a nationally-known Company of high standing. Refer to page 81 for our advertisement in this issue. In writing, give full information concerning your qualifications.

FLYNN & EMRICH CO.
Holliday and Saratoga Sts., Baltimore, Md.

New "SEARCHLIGHT" Advertisements

must be received by December 22 to appear in the January issue.

Address copy to the Departmental Advertising Staff

Power
330 West 42d St., New York City

WANTED

WANTED

ENGINE GENERATING SET

1—180-200 kw. 4 valve or uniflow non-condensing 220 volts, 3 ph., 60 cy. State all particulars.

W-645, Power
330 W. 42d St., New York City

WANTED

High Class, 120 kw., Engine Generating Set. Free exhaust, 220 volts, 3 phase, 60 cycle.

State all particulars

W-646, Power
330 West 42d Street, New York City

MODERNIZING AND SAVING WITH USED EQUIPMENT

Quoted from an article in the November 1936 issue of Power titled "ITS OWN MEDICINE: COAL MINE GENERATES ITS POWER AT A SAVING OF $10,000 A YEAR."

—"this leaves a screening for which the market is very limited—"

—"Realizing this — — last year retained a consulting engineer, and began modernization of its power plant—."

—"A used 625 KVA Allis-Chalmers condensing turbo-generator costing $7,500 and a temporary forced-draft system were installed—"

—"The monthly saving is then $1,491.00—$609.55 or $881.45 which amounts to $10,577.40 a year".

Used Equipment Advertising pages 107 to 113

ΚΕΚΤΗΣΘΑΙ ... ἅπαξ λεγόμενον

BELYEA SPELLS *Satisfaction* IN ANY LANGUAGE

GUARANTEED RE-NU-BILT

MOTOR GENERATOR SETS

3 PH., 60 CY.

2—2000 KW Allis Chalmers DC Gen. 275 V., Interpole Type conn. to: Synch. Motor 12,000/6600 V., 300 RPM., 25 cy.

1500 KW G.E. Type MPC, D.C. Gen., 275 V. comp'd Interpole, conn. to: 2150 HP. .8 P.F. Synch. Motor, type ATI, 11,431/6600 V., 360 RPM.

1000 KW G.E. Type MPC, D.C. Gen. 250 V., conn. to 1400 HP. Synch. Motor, 6300/2300 V., 514 RPM.

600 KW G.E. Type MPC, D.C. Gen. 250 V. Com'd Interpole, conn. to 850 HP Synch. motor type ATI, 6900/11990 V. 900 RPM.

500 KW G.E. type MPC, D.C. Gen. 250 V. Com'd. Interpole Conn. to 710 HP Synch. motor, Type ATI, 4150 V. 720 RPM.

200 KW Crocker-Wheeler Type 149DA Comp'd Interpole, 250 V. dir. conn. 300 HP IND. Motor, 2300/220 V. 575 RPM.

100 KW G.E. type MPC, 250 V. Comp'd Interpole, dir. conn. to 150 HP synch. motor, type ATI, 2300 V. 900 RPM., complete with D.C. gen. switchboard & synch. motor starting panel.

100 KW Westinghouse D.C. Gen. 250 V. Comp'd Interpole, conn. to 150 HP Syn. Motor 2200 V. 1200 RPM.

75 KW Westinghouse, Type SK, D.C. Gen. 250 V. Comp'd Interpole, connected to AC Motor 220/440 V. 900 RPM.

50 KW Westinghouse, Type SK, DC Gen. 250 V. Comp'd Interpole, conn. to 75 HP Sq. Cage, Type CS 220/440 V. 900 RPM.

50 KW Westinghouse Type SK, DC Gen. 125 V. Comp'd Interpole, conn. to Synch. Motor, 220 V. 1200 RPM.

40 KW Westinghouse, Type SK, DC Gen. 250 V. Comp'd Interpole, conn. to 60 HP Sq. Cage Type CS, 220/440 V. 1200 RPM.

35 KW G.E. Type RMC, 35 V. 1000 Amp. conn. to 60 HP Sq. Cage, 220/440 V. 900 RPM.

25 KW G.E. Type RC-31, DC Gen. 125/125 V. Comp'd Conn. to 40 HP Sq. Cage AC Motor, 220/440 V. 1740 RPM.

25 KW West. Type SK, D.C. Gen. 250 V. Comp'd Interpole Conn. to: 40 HP West. Sq. Cage AC Motor, Type CS, 440/220 V.

24 KW G.E., DC Gen. 30 V. 800 Amp., conn. to 37½ HP Sq. Cage, 220/440 V. 900 RPM.

15 KW G.E. 115/230 V. 3-Unit Set consisting of: 2—7½ KW DC Gen., Comp'd. WD., 115 V., 1800 RPM., coupled to: 25 HP. synch. motor, 220 V., 1800 RPM, mounted on C.I. base.

5.4 KW Westinghouse, Type SK-40, DC Gen. 75 V. Comp'd Interpole, conn. to 10 HP Sq. Cage, Type CS, 220/440 V. 1750 RPM.

3 KW G.E., DC Gen. 30 V. 100 Amp. conn. to 6 HP Sq. Cage. 220 V. 1200 RPM.

A. C. MOTORS—60 Cy.

SYNCHRONOUS TYPE

H.P.	Make	Type	Volts	Speed
2850	G. E.	ATI	2300/4150	450
850	G. E.	ATI	2300	720
600	Al. Ch.		440	450
500	G. E.		440	1200
500	West.		2300/4150	720
400	West.		2300/4150	720
225	Elec.Machy.	3-BRG	4150/2300	450
220	G. E.	ATI	2300	900
200	West.		440	514
100	West.		2300/4150	1750
75	West.		440/200	900
75	Cr. Wheeler		440/220	1200

SLIP RING TYPE

H.P.	Make	Type	Volts	Speed
600	G. E.	MT-542Y	2300/550	257
400	G. E.	MT-424	4150/2300	390
450	West.	CW	220	875/700
400	West.	CW-1416	2200	290
400	G. E.	IM	440/220	505
400	West.	CW	2300	514
400	G. E.	I-M	2200	885
300	Al. Ch.	ANY	2200	585
250	G. E.	MT-424Y	4000/2300	257
250	West.	CW	440/220	585
250	F. Morse	BV	2200	1200
225	G. E.		440/220	1800
200	West.	CW	440/220	575
200	West.	CW	2200	870
200	West.	CW	440/220	900
200	G. E.	I-M	440/220	900
150	Al. Ch.		440/200	600
150	G. E.	IM	2200	875
150	G. E.	IP	440/220	870

SQUIRREL CAGE

H.P.	Make	Type	Volts	Speed
1—300	Cr. Wh.	AQ	2300/220	580
1—250	West.	CS	2300/440	580
1—200	West.	CS-876A	220/440	1160
1— 75	West.	CS	220/440	870
1— 75	West.	CS	220/440	600
2— 60	Cr. Wh.	Ball Br.	220/440	1155
1— 60	G. E.	I	220	900
1— 50	G. E.	KT	220/440	870
1— 50	West.	CS	220/440	580
1— 50	G. E.	KT	220/440	870
1— 50	West.	CS	220/440	870
1— 50	West.	CS	220/440	1170

SPECIAL

FOUR WORTHING-LAIDLAW DUPLEX AIR COMPRESSORS

24x14x18 Comp. with overhead intercoolers, piston displacement 1860 C.F.M. disch. press. 100 lbs., speed 200 dir. conn. to 350 HP. G.E. synch. motors, 2200v, 200 RPM, 3 ph., 60 cy., complete with control.

A. C. GENERATORS

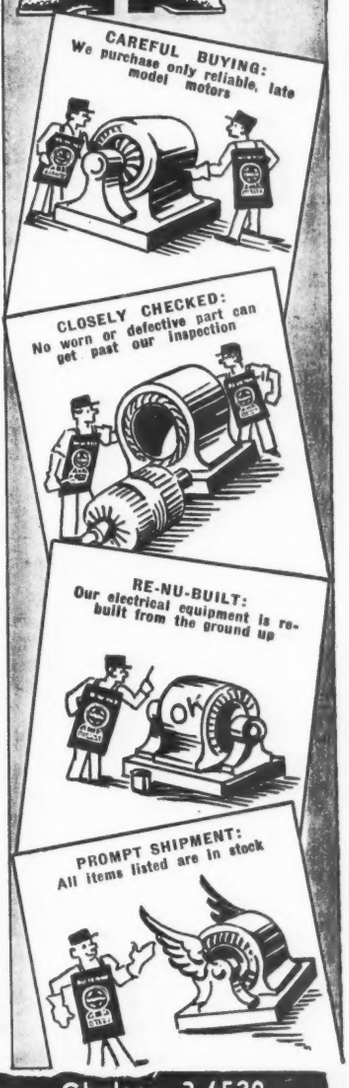
3 PHASE—60 CYCLE

	Make	Type	Volts	Speed
937 K.V.A.	Allis-Chal.		2300	450
750 K.V.A.	West.		480	3600
700 K.V.A.	G. E.	ATI	2300	700
450 K.V.A.	Allis-Chal.		230	240
415 K.V.A.	West.		2300/4150	720
300 K.V.A.	Allis-Chal.		240/480	600
225 K.V.A.	G. E.	ATB	2300	900
100 K.V.A.	G. E.	ATB	2300	900
100 K.V.A.	Western		480/240	900
100 K.V.A.	West.		2300	900
75 K.V.A.	G. E.	ATB	2300	900
75 K.V.A.	West.		480/240	900
75 K.V.A.	Cr. Wheeler		480/240	1200

D. C. MOTORS

ADJUSTABLE SPEED—230 V.

H.P.	Make	Type	Speed
1—250/410	Cr. Wheeler	CMC-151-H	1000/1200
1—250	West. 3 Bear.	SA	250/750
1—125	West.	SK-210	240/600
2—120	G. E.	DMC	300/750
3— 80	Diehl	K11-40	550/1100
1— 75	G. E.	RF-17	300/900
1— 75	G. E.	CD	575/870
2— 60	El. Dy.	25-S	450/1200
5— 60	El. Dy.	25-S	525/1050
2— 50	West.	SK-190	225/600
1— 50	West.	SK-160	600/1200
12—40/50	Cr. Wheeler	EM	175/700
2— 40	West.	SK	120/240
1— 40	West.		300/900
2— 35	West.	SK	500/1500
1— 30	El. Dy. B.B.	10-S	800/1600
15—20	G. E.	LC	650/1950
1— 20	G. E.	RF12	500/1500
1— 20	G. E.	RF11	500/1500
1—18/22	West.	SK-160	133/266
1— 15	El. Dy.	10-S	450/1350
1— 15	Reliance	E	400/1600
1— 15	El. Dy. B.B.	10-S	450/1350
1— 12½	West.	SK	177/350
15—10	West.	SK-90	500/1500
2—10	G. E. (B.B.)		600/1800
1— 10	G. E.	RF-12	325/1300
1— 10	G. E.	RF-10	550/1650
2— 7½	G. E.	RF-10A	450/1800
20— 7½	West.	SK-80L	400/1600
20— 7½	West.	SK-70L	500/1500
15— 5	West.	SK-70L	400/1600
1— 5½	West.	SK	600/1800
10— 3½	West.	SK-40	450/1800
3— 2½	West.	SK-30	450/1800


CAREFUL BUYING:
We purchase only reliable, late model motors
CLOSELY CHECKED:
No worn or defective part can get past our inspection
RE-NU-BUILT:
Our electrical equipment is re-built from the ground up
OK
PROMPT SHIPMENT:
All items listed are in stock

Telephone - Wire - Write. Above is only partial listing. Telephone—Chelsea 3-6520

BELYEA CO., INC.

143 West 18th St., NEW YORK, N. Y.

THE FINEST REBUILT EQUIPMENT MONEY CAN BUY

Ready For Immediate Shipment

Teletype Designation Union City, N. J. 1750

CHICAGO REP., HOWARD B. JOHNSON, 53 W. JACKSON BLVD.

MOTOR GENERATOR SETS

1—200-kw., 125-V., G. E., Synchronous.
1—200-kw., 250/275-V., Allis-Chalmers, Synchronous.
1—175-kw., 250-V., Crocker-Wheeler, Sq. Cage.
1—150-kw., 250/275-V., Ridgeway, Synchronous.
1—150-kw., 125-V., G. E., Synchronous.
1—150-kw., 250-V., Westinghouse Synchronous.
1—125-kw., 250-V., G. E., Synchronous.
2—100-kw., 125-V., G. E., Sq. Cage.
1—100-kw., 125-V., G. E., Synchronous.
1—100-kw., 250-V., Westinghouse Synchronous.
1—75-kw., 125-V., Crocker-Wheeler, Synchronous.
1—75-kw., 250-V., G. E., Synchronous.
1—50-kw., 250-V., Westinghouse, Synchronous.
1—50-kw., 125-V., G. E., Sq. Cage.
1—50-kw., 250-V., G. E., Sq. Cage.
200-kw., 250-V., G. E. Synchronous.
37½-kw., 250-V., Westghse. Sq. Cage.
30-kw., 125-V., Fairbanks-Morse, Sq. Cage.
25-kw., 125-V., Allis-Chalmers, Sq. Cage.
10-kw., 125-V., G.E. Sq. Cage.
1500 amp., 20-V., Rogue plating set.
2500/1250 amp., 6/12, Hansen Van Winkle Plating Set.

TURBINES

1—625-kw., 3-ph., 60-cy., 480-V., Bleeder Whse.
1—625-kw., 3-ph., 60-cy., 480-V., Non-Condens. Whse.
1—500-kw., G.E., 3600 R.P.M., direct connected exciter, generator on
1—50-kw., 125-V., G. E.-Kerr. Turbine Pump, 3500 gal. per min., 135 ft. head.

TRANSFORMERS

3—500-kva., Wagner, 2400/240/480-V.
3—300-kva., 3-ph., Pittsburgh, 4800/2400/240/120-V.
2—150-kva., Westinghouse, 2300/230/115-V.
12—100 kva., General Electric, 2400/4800-240/120 volts.
4—100-kva., Westinghouse, 2200/440/220/110-V.
3—100-kva., G.E., 7800/440/220-V.
1—75-kva., G.E., 480/110/230-V.
8—50-kva., General Electric, 2400/4800-240/120-V.
1—37½-kva., G.E., 240/120-V.
1—31½-kva., G.E., 440/110-V.
5—25-kva., Westinghouse Air Cooled, 440/220/220/110-V.

SPECIALS

2—500 GPM, Worthington, 275 ft. head, pumps, G.E. slip ring motors.
1—7000 GPM, Kingsford, 135 ft. head, G.E. squirrel cage motor.
1—3500 GPM, Kingsford, 135 ft. head, G.E. squirrel cage motor.
2—150 HP., 850 R.P.M., 110-V., G.E., R.C. motors.
1—205 KVA., 4150-V., 3-ph., 2300-V., 2-ph., Westinghouse.

1—25-kva., G.E., 440/110-V.
1—25-kva., American, 220/220/110-V.
1—25-kva., G.E., 220/220/110-V.
4—21-kva., G.E., 440/110-V.
2—20-kva., Westinghouse, 440/220/110-V.
3—15-kva., G.E., 440/120-V.
4—15-kva., Westinghouse Air Cooled, 220/440/220/110-V.
1—10-kva., G.E., 440/220/110-V.

A.C. GENERATORS

720-kva., 514 r.p.m., 4000/2300-V., G. E. Syn. Condenser.
350-kva., 600 r.p.m., 240-V., Westinghouse.
300-kva., 600 r.p.m., 2300-V., Westinghouse.
200-kva., 720 r.p.m., 220-V., G.E.
200-kw., 600 r.p.m., 2300/4000-V., G.E.
150-kva., 500 r.p.m., 2300-V., 25-cy., G.E.
150-kw., 450 r.p.m., 220-V., Westinghouse.
100-kw., 900 r.p.m., 220-V., G.E.
75-kva., 300 r.p.m., 2400-V., Westinghouse.
75-kva., 1200 r.p.m., 2300-V., G.E.
50-kw., 300 r.p.m., 2300-V., G.E.
42-kva., 1200 r.p.m., 2400-V., Elec. Machy.
2—7½-kw., 1800 r.p.m., 240-V., G.E.

D.C. MOTORS—230 Volts

1—750-hp., 600 r.p.m., Allis Chalmers.
1—240-hp., 550 r.p.m., G.E.
1—215-hp., 750 r.p.m., G.E.
1—125-hp., 850 r.p.m., G.E.
2—175-hp., 500 r.p.m., G.E.
1—125-hp., 490/610 r.p.m., Crocker Wheeler.
1—100-hp., 950 r.p.m., G.E.
1—100 hp., 900 r.p.m., G.E.
1— 60-hp., 1050 r.p.m., G.E.

D.C. GENERATORS

1—500-kw., 720 r.p.m., 250-V., Westinghouse.
1—100-kw., 750 r.p.m., 125-V., G.E.
1—100-kw., 600 r.p.m., 125/250-V., G. E.
2— 75-kw., 1200 r.p.m., 125-V., Crocker Wheeler.
1— 75-kw., 550 r.p.m., 50-V., G.E.

MOTORS—3 PHASE, 60 CYCLES

No.	H.P.	R.P.M.	Volts	Type
1	500	450	2200/4000	G.E. Sl. Rg.
1	500	900	440/4000	West. Syn.
1	400	514	2200	West. Sl. Rg.
1	300	514	2200	Al.-Ch. Sl. Rg.
1	300	600	2200	Cr.-Wh. Sl. Rg.
2	200	900	440	G.E. Sl. Rg.
2	200	514	220/440/4000	G.E. Syn.
4	200	450	2200/4000	G.E. Sl. Rg.
2	200	514	2200/4000	G.E. Sl. Rg.
1	400	514	440	G.E. Sq. Cg.
1	250	600	4150	G.E. Syn.
1	165	1750	440	Al.-Cl. Sq. Cg.
1	150	1160	440	West. Sl. Rg.
1	160	600	440	G.E. Sl. Rg.
1	125	900	440	G.E. Sl. Rg.
2	100	900	440	G.E. Sl. Rg.
2	100	720		G.E. Sq. Cg.
	100	600	220	G.E. Sl. Rg.
1	100	450	220	Sl. Rg.
1	79	1160	440	G.E. Sl. Rg.
1	75	1800	2200	G.E. Sq. Cg.
1	75	900	4150	Elc. Machy. Syn.
2	75	720	220	G.E. Sq. Cg.
1	75	600	220	West. Sl. Rg.
1	75	514	220	G.E. Sq. Cg.

Variable Speed 230 Volt Motors

H.P.	R.p.m.	Type
200	275/550	G.E.
125	475/950	Westinghouse
90	470/940	G.E.
35	500/1500	G.E.
35	500/1250	G.E.
30	600/1200	West.
20	750/1500	G.E.
20	375/1500	West.
20	400/1200	G.E.
4—20	300/1200	G.E.
3—15	300/1200	G.E.

J. L. HEMPHILL & CO., INC. 801 Williams St., No. Bergen, N. J.

NEW YORK LINE LONGACRE 5-3227 N. J. TEL., PALISADE 6-2600

COMPLETE PLANT

(2) **200 KW Ridgeway** 250 volt generators with Ridgeway 4 V. engines, with switchboards. Still operating. Priced low for quick sale before removal. Location Brownsville, Pa.

Also 100 KW. 3-wire Burke generator with Ames Uniflow Engine.

POWER PLANT EQUIPMENT CO., INC.

39-41 Cortlandt St., New York City, N. Y.

-TRANSFORMERS-

A Complete Stock. Prompt Shipment.

3—667 KVA Gen. Electric Transformers, 1 phase, 60 cycle, 11500—460 volts **$870.00 EACH**

We Rewind, Repair and Redesign all Makes and Sizes.
ALL TRANSFORMERS GUARANTEED FOR ONE YEAR.

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THE ELECTRIC SERVICE CO., INC.

"AMERICA'S USED TRANSFORMER CLEARING HOUSE"

STATION M CINCINNATI, OHIO

Electrical Equipment

Bought and Sold

Motors, Generators, Transformers, Rotary Converters, Engine Generator Sets, Motor Generator Sets, Turbo Generators, etc.

GEORGE SACHSENMAIER CO.

8403 Hegerman St. Philadelphia, Pa.

ECONOMIC BOILERS

All sizes from 40 to 90 hp.
A.S.M.E. Get our prices.

M. J. HUNT'S SONS

1600 N. Delaware Ave., Philadelphia, Pa.

MODERN SUB-STATIONS

1—300 Kw. Ridgway Syn. Mot. Gen. Set, 275 v., 1200 rpm., 2300-4000 v., .8 P.F., Comp. Man. Control.
1—200 Kw. Whse., Syn. Con., 250 v., 1200 rpm., 2300-4000 v., a.c. trans. man. con.
1—150 Kw. G.E. Syn. Mot. Gen. Set, 250 v., 1200 R.P.M., .8 P.F., 2300-4000 v., A.C. Manual Control.

WALLACE E. KIRK COMPANY

Grant Building Pittsburgh, Pa.

Dealer Stocks include Good Used Equipment that will enable many plants — whose buying is restricted by limited funds — to modernize equipment or operations to accomplish desirable cost-reducing savings.

THE PICK OF POWER EQUIPMENT

TURBINES	GENERATORS
ENGINES	MOTORS
BOILERS	TRANSFORMERS
PUMPS	ROTARIES
CONDENSERS	COMPRESSORS
HEATERS	CRANES, ETC.

30 years of National Service

BREW, WOLTMAN & CO., INC.

50 CHURCH STREET, NEW YORK CITY

"We Live on our Reputation"

SQUIRREL CAGE

HP	Make	Volts	Type	RPM
115	G. E.	220	1.E. 13A	1200
100	West.	550	C.S.	1800
100	G. E.	440	IST 556	900
100	West.	220	CS754C	900
2–100	West.	440	CS854C	720
100	G. E.	220	KT558	720
75	Cont.	440	A.89X	1800
75	G. E.	220	KT 537	1800
60	G. E.	220	FT 327Y	3600
60	G. E.	440	KT558S	430

SLIPRING MOTORS 25 CY.

HP	Make	Volts	Type	RPM
100	G. E.	440	MTC553S	720
50	G. E.	440	MTC5347	460
25	G. E.	440	Mt 337	720
25	West.	440	CW653C	720

HOIST DUTY MOTORS

HP	Make	Volts	Type	RPM
5–100	West.	220	CI663C	1800
100	G. E.	220	KTR 546	900
5– 75	West.	220	CI 653C	1800
3– 60	West.	220	CI	1800
50	Ideal	440	AVEC	1200
25	G. E.	220	MWC5325	720
3– 20	G. E.	220	MTE 322	660
5– 20	P & H	220	AW 9	1200
20– 1	R & M	220/440	PP 19	1200
6– 1	F & M	220/440	HWRE	1200

TOTAL ENCLOSED FAN COOLED

HP	Make	Volts	Type	RPM
30	Wagner	440	CP445	900
30	Howell	220	BB36-6	1800
20	Wagner	440	CP 364	1800
2– 15	Howell	220	KRB316	1200
2– 10	Allis Chal.	440	AR	900
5	G. E.	220	KC 284	1800
3–4.8ft. lbs.	G. E.	220	KR 202	900
4– 2 HP	Wagner	440	CP 224	3600
2	G. E.	220	KT3936	1800

SLIPRING MOTORS

HP	Make	Volts	Type	RPM
200	G. E.	220	M 17	600
75	G. E.	440	MT552	900
2– 60	CW	220		720
50	G. E.	220	MT 343	1200
50	Ideal	440	AVEC	1200
50	CW	220	21Q	1200
50	West.	220	CW744	1200
2– 50	CW	220		900

MULTI-SPEED TOT. ENC. HOIST MOTORS

HP	Make	Volts	Type	RPM
3–2½ to ⅝	F & M	440	HRXE4C	1800/450
2–2½	Cleve.	440	352	1800/450
3–2/1¾	F & M	440	HRXE6E	1800/450
6–3½/1½/1⅛	F & M	220	HRXE6E	1200/450
2–3½/1/1/3	F & M	440	HRXE6E	1200/450
2–3½	Cleve.	220	352	12/6/500
4.2/1.9/1.1	CW	208	SCA326	9/6/500
3–6	Cleve.	440	352	1200/450
6–5/2½/1⅞	F & M	220	HRXE8D	12/6/450
2–6/2¼	F & M	440	HRXE8D	1200/450
7/2.62	F & M	220	HRXE6E	1200/450
3–10/3¾	F & M	220	HRXE8E	1200/450
15/10/7½/5	West.	440	CS485C	1800/600

SYNCHRONOUS MOTORS

HP	Make	Volts	Type	RPM
150	West.	2300		720
	exciter	3.75 KW	125 Volts	DC
2–30	G. E.	2300	TS7543P	1800
	exciter			
20	Fl. Weische	220	15VRN	1200
20	Ft. Weische	220	15VRN	1200
20	Fl. Weische	220	19TRM	900
15	Ft. Weische	220	13VRN	1800
3– 10	Fl. Weische	220	10VRN	1800

SQUIRREL CAGE MOTORS

HP	Make	Volts	Type	RPM
75	G. E.	440	KT357	750
40	West.	220	CS	750
3– 25	G. E.	440	KT 337	750
20	G. E.	440	FTR527	750
20	G. E.	220/440	FT5134	1450
15	G. E.	440	KT 327	715
2– 15	G. E.	440	KT503Y	1450
3– 10	G. E.	440	KT 312	750
7½	G. E.	550	KT 751	1200
7½	G. E.	440	KT 954	750
7½	G. E.	440	KT 302	750

MOTOR GENERATOR SETS

600 amp.— G. E.—60 — 3 bearing direct connected to 50 HP — KT 336 — 1800 rpm — 220 volts.

400 amp., Ser. No. over 850,000.

50 KW — West.— 125V. DC — 3 bearing direct connected to 75 HP — 220 V— 900 rpm — 3 ph 60 cy. motor.

16 KW — West.— 125 V — SK 80L — 3 bearing direct connected to 25 HP 440 V — CS — 1800 rpm motor.

125 KW General Electric 550 volt DC motor generator set. 3 phase — 60 cycle serial over 4,000,000.

WEXLER ELECTRIC MOTOR CO., INC.

124 Baxter St. **New York, N. Y.**

SLIP RING MOTORS, 3-PH., 60-CY.

HP	Volts	Make	Speed
400	440-220	G.E.	450
220	440-220	G.E.	600
200	2200-440-220	G.E.	600
150	2200-220-440	G.E.	720
150	220-440-550	G.E.	600
100	2200-440-220	Westghse.	1200
100	2200-440-220	G.E.	720
100	2200-550	Westghse.	900
100	440-220	G.E.	900
75	220-440	G.E.	720
50	2200-440-220	G.E.	1200
50	440-220	G.E.	600

SYNCHRONOUS MOTORS 3-PH., 60-CY.

350	2200-440-220	G.E.	180
240	2300	G.E.	900
240	2200-440-220	G.E.	600
200	2200/4000	G.E.	514
125	220-440	Westghse.	900
120	2200-440-220	G.E.	900
120	2200-550-440	G.E.	1200
120	2200-440-220	G.E.	600

A. C. GENERATORS

1—330 kva., 900 r.p.m., 240-480-V., G.E.
1—300 kva., 900 r.p.m., 240-480-V., Al.-Chal.
1—225 kva., 600 r.p.m., 2200-240-480-V., G.E.
1—225 kva., 900 r.p.m., 2300-V., G.E.
1—112½ kva., 1200 r.p.m., 2200-240-480-V., G.E.
1—112½ kva., 900 r.p.m., 240-480-V., G.E.
1—112½ kva., 600 r.p.m., 2200-480-240-V., G.E.
1—100 kva., 900 r.p.m., 240-480-V., Westghse.
1—62½ kva., 500 r.p.m., 2300-240-480-V., G.E.

TRANSFORMERS—60 CYCLE

3—1250 kva., Allis-Chalmers, 33000-2300/4000 Y.
3—500 kva., G.E., type H-KDD, 13800-460/230/115.
3—300 kva., Pittsburgh 2200-220/440.
3—250 kva., G.E., type H-KDD, 11970-2300.
3—250 kva., G.E., type H-KDD, 6900-230/115.
3—150 kva., G.E., type H-KD, 4000-230/460.
3—150 kva., G.E., type H-KR, 13200-240/480.
3—100 kva., G.E., type H-KS, 2200-220/110.
3—50 kva., Pittsburgh, 13800-120/240.
3—25 kva., G.E., type H-K, 2200-220/110.
3—25 kva., G.E., type H-K, 2200-220/440.

SQUIRREL CAGE MOTORS

HP	Volts	Make	Type	Speed
250	2300	G.E.	KT	1800
250	440-550	G.E.	IE	1200
200	550	G.E.	IK	900
150	2200-440-220	Whse.	CS	600
100	550	G.E.	KT	900
100	440-220	G.E.	IK	600
100	220-440	G.E.	KT	1800
100	220-440	G.E.	KT	1200
75	220-440	G.E.	KT	720
75	2200-440	G.E.	KT	1200

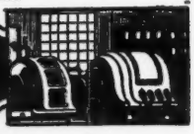
DIRECT CURRENT MOTORS

HP	Volts	Make	Type	Speed
100	230	Whse.	SK	625
100	230	G.E.	LC	1150
80	230	G.E.	RC	600
75	230	Whse.	SK	475
75	230	G.E.	RC	950

MOTOR GENERATOR SETS

1—200 kw., 125-V., 1200 r.p.m., G.E., type MPC connected to type TS. 300 hp., 2300/440-V. 60 cy., syn. motor.
1—125 kw., 125-V., 1200 r.p.m., G.E. type MPC connected to type ATI, 165 kva., .8 PF. 220/440-V., 60 cy., syn. motor.

STEPHEN HALL & COMPANY, INC.
7th and Adams St., Hoboken, N. J.



UNIFLOW UNITS

750 KVA G.E. 3-60-440/220 alternator, with Ames Uniflow Engine; exciter, switchboard. Still on foundation. Location Passaic, N. J. Priced low for quick sale before removal. Will sell engine and generator separately if so desired.

Also (2) 150 KW G.E. synchronous Motor Generator Sets, complete.

POWER PLANT EQUIPMENT CO., INC.
39-41 Cortlandt St., New York City, N. Y.

TURBO GENERATORS

1–5000 KW, Westinghouse, 3/60/2300-v, 250#-600 deg. T.T. Condens'g.

2–2500 KW, Allis Chalmers, 3/60/2300-v, 200#-450 deg. T.T. Condens'g.

1–2000 KW, G. E. 3/60/2300-v, 250#-600 deg. T.T. New, Condens'g.

2–1000 KW, Allis Chalmers, 3/60/480-v, 200#-450 deg. T.T. Condens'g.

1–1000 KW, Allis Chalmers, 3/60/2300-v, 200#-15# B.P., Noncondens'g.

1– 750 KW, G. E. 3/60/2300-v, 250#-600 deg. T.T. 30# Automatic Extr.

WALTER H. WILMS & COMPANY
1522 UNION GUARDIAN BLDG., DETROIT, MICHIGAN

MODERN AIR COMPRESSORS VACUUM PUMPS

All Types and Sizes

Rebuilt - Guaranteed

EARL E. KNOX COMPANY
21 West Second St., Erie, Pa.

POWER PLANT EQUIPMENT

TURBO-GENERATORS

2000 kw. G. E. 2300 v. Cond.
1000 kw. West. 480 v. Extraction.
750 kw. G. E. 2300 v. Extraction.
625 kw. Allis 480 v. Cond.
500 kw. G. E. 2300 v. Cond.
300 kw. G. E. 550 v. N. Cond.
100 kw. G. E. 550 v. N. Cond.
2000 kw. West. Turbine Only 82 lbs. B.P.

BOILERS

823 H.P. Sterling, 200 lbs.
604 H.P. B. & W. 200 lbs.
150 H.P. Dillon H.R.T. 153 lbs.
78 H.P. Ames Self Cont. 125 lbs.

AIR COMPRESSORS

360 cu. ft. Chic. 12x10 100 lbs.
360 cu. ft. I. R. 12x10 100 lbs.
1775 cu. ft. I. R. Duplex 25 lbs.
1860 cu. ft. Worthington 100 lbs.
Others from 92 ft. up.

Also Engine and Motor Generator Sets, Transformers and Equipment of every description

A. Lee Ellis Co., U. S. Mchy. Bldg., Boston, Mass.
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REBUILT ELECTRIC MOTORS

Over 10,000 items in stock for immediate delivery—Rochester, N. Y., or Toledo, Ohio, shipment. Rebuilt equipment sold with standard new guarantee. We buy used equipment—25 & 50 cy.—send us your offerings.

BERGER BROS. ELECTRIC MOTORS INC.
1346 UNIVERSITY AVE., ROCHESTER, N. Y.
Phone Monroe 2094

Diesel Generator Set

30 K.W. Ideal Electric, 115 v., d.c., 850 r.p.m., connected to 60 hp. Cummins, 6 cyl. Diesel engine. New 1931. Bargain.

THE O'BRIEN MACHINERY CO.
113 N. Third St. Philadelphia, Pa.

WE BUY AND SELL

Power Plants, D.C. and A.C. Motors, Generators, Transformers, Pumps and Elec. Instruments. Give us the opportunity of bidding. NOTE: We carry a diversified stock and your inquiries will receive immediate attention. Satisfaction guaranteed.

Superior Electric Machinery Co.
253 N. Third St. Philadelphia, Pa.

SYNCHRONOUS CONDENSER

600 K.V.A. 2 phase 60 cycle 2300 volt 900 rpm General Electric synchronous condenser, complete and in excellent condition.

SYNCHRONOUS MOTOR

350 HP. 3 phase 60 cycle 550 volt 720 rpm General Electric latest type, serial number over five million, with automatic panel.

1—350 HP. Farrell reduction gear suitable to drive 3—60" rubber mills.

VARIABLE SPEED MOTOR

25/100 HP. Westinghouse 115/230 volt 250/100 rpm type SK, with automatic Cutler-Hammer control, rubber mill duty.

ANDREN-MYERSON CORP.
411 Atlantic Ave. Boston, Mass.

SPECIAL FOR THIS MONTH

300 Transformers, all sizes.
1—100 hp. 60/3/2200/1800.
15— 10 hp. 60/3/220/1200.
5— 15 hp. 60/3/220/1200.
2— 25 hp. 60/3/220/1800.
2— 25 hp. G.E. KT 536 60/3/220/720.
50—¼ hp. G.E. motors 60/220/3/1800.
3—3 hp. G.E. Slipring, 60/3/440/1800.
1—75 hp. West. cs—25/3/2200/750.
107—Grinding & Buffing Mandrels.
7—25 hp. 60/3/440/1200.

We want to buy for cash 25 cycle 1 and 3 phase motors.
Wire, Write or 'phone
Erie Electric Motor Repair Co., Inc.
124 Church St., Buffalo, N. Y.

Dealer Stocks include Good Used Equipment that will enable many plants — whose buying is restricted by limited funds — to modernize equipment or operations to accomplish desirable cost-reducing savings.

MOTORS GENERATORS

L.J. LAND

141 Grand St. N.Y.-Est.1910

230 VOLT D.C. MOTORS

HP	Make	Type	RPM
150	Gen. Elec.	RC	1750
100	West.	SK (2)	625
75	West.	SK	850
75	El. Dyn.	25S	700/1050
75	El. Dyn.	311N (3)	400
60	Gen. Elec.	RC	1050
15	West.	SK	700
15	West.	SK	600/1500
10	Star	5B5	3600
10	Gen. Elec.	RC	1700
10	Gen. Elec.	CD (2)	1100
10	Gen. Elec.	RC	1150
10	Gen. Elec.	LC	1000/1500
10	West.	SK83	400/600
10	Gen. Elec.	RC (2)	850
10	West.	SK (2)	850
10	Gen. Elec.	RC	700
9	Gen. Elec.	CVC	1150
7½	Sturtevant	TF	3500
7½	Gen. Elec.	CD	1750
7½	Cr. Wheeler	CCM	1150
7½	West.	SK	650
7½	Gen. Elec.	RF	600/1800
5.6	West.	SK60	500/1500
5	Gen. Elec.	CD (2)	1750
5	Gen. Elec.	BD	1200
5	West.	SK (2)	1150
5	Gen. Elec.	RC	1150
5	Gen. Elec.	CD	1150
5	Cr. Wheeler	CCM (2)	950
5	Gen. Elec.	CO-1802	875/2700
5	West.	SK	850
5	Gen. Elec.	RF	475/1425
5	Reliance	46TF	400/1600
3½	West.	SK	450/1800

87—¼ to 5 HP—all speeds

SYNCHRONOUS MOTORS

187 HP Gen. Elec. ATI, form PB, 3 ph. 60 cy. 220 volt, .8 P. F., 900 RPM, direct connected exciter.
125 HP Elec. Machy., 3 phase, 60 cy. 220/440 volts, 1800 RPM, direct connected exciter (2).
100 HP Gen. Elec. ATI, form PB—.8 P. F., 3 ph., 60 cy., 220/440 volts, 1200 RPM, direct connected exciter.
75 HP Westinghouse, 3 ph., 60 cy., 220/440 volts, 1200 RPM.
75 HP Elec. Machy., 3 ph., 60 cy., 220/440 volts, 1200 RPM, direct connected exciter.

D.C. GENERATORS

Belted and Direct Motor Driven—125 Volts

100 K.W. General Electric 3 bearing synchronous Motor Driven.
55 K.W. Westinghouse 600 RPM.
50 K.W. General Electric.
45 K.W. General Elec. 975 RPM.
40 K.W. Westinghouse, 3 bearing synchronous Motor Driven (2).
40 K.W. Gen. Elec. CD, 1200.

D.C. GENERATORS

Belted and Direct Motor Driven—250 Volts

225 K.W. Diehl, 300 RPM.
50 K.W. West., 3 bearing, M.D.
50 K.W. Gen. Elec., 1200 RPM.
50 K.W. Crocker Wheeler, 1800.

FREQUENCY CHANGERS

80 K.W. General Electric ATB, 100 cycles, 366 volts, 1200 RPM.
50 KVA. G. E. ITT, 90 & 120 cycles.
40 KVA. G. E. ITT, 90 & 120 cycles.
25 K.W. G. E. ITT, 90 & 120 cycles.
20 K.W. G. E. ITT, 180 cycles.
20 K.W. G. E. ITT, 90 & 120 cycles.

ELECTRIC HOISTS A.C. and D.C.

5 Ton Gen. El. Sprague, 220 D.C.
4 Ton G.E. Sprague, 220 D.C. (5).
3 Ton G.E. Sprague, 220 D.C. (3).
2 Ton Shepard, A.C.
1½ Ton Chis. & Moore, A.C.
1 Ton American, 220 D.C.
1 Ton Euclid A.C.
1 Ton G. E. Sprague, 115 D.C.
½ Ton Shepard, 220 D.C. (5).
¼ Ton Shepard, 110 D.C.

MISCELLANEOUS

5 K.W. Holtzer Cabot High Frequency Generator, 500 cycles, driven with 120 volt D.C. motor.
6½ KVA Cr. Whr. High Freq., 500 cycles, Gen. driven by 120 volt D.C. motor.
5 K.W. General Electric High Cycle Generator with A.C. motor.
100 ampere Lincoln Welder.
1000/500 ampere Columbia Plater.
15—16 to 42" A.C. and D.C. Exhaust Fans.

SLIP RING A.C. MOTORS

2 and 3 Phase

HP	Make	Type	RPM
200	Fair.-Morse		600
150	West.	CW	1200
125	Cr. Wheeler	125AQ	600
100	Wagner		1200
100	Gen. Elec.	MT556	900
100	Fair.-Morse	BA	720
100	Gen. Elec.	IM	720
100	West.	CI	720

SQUIRREL CAGE A.C. MOTORS

2 and 3 Phase

HP	Make	Type	RPM
220	Cr. Wheeler		720
150	Gen. Elec.	IK	720
100	Al. Chalmers	AR	1750
100	West.	CS	700
100	West.	CS	900
40	Gen. Elec.	KT312	1800
40	West.	CS	1200
40	Gen. Elec.	KT542	900
30	West.	CS	1800
30	Wagner	19TBP	1800
30	Gen. Elec.	KT332	1200
30	West.	CS (5)	1200
30	Wagner	BP	1200
30	Fair.-Morse	B	1200
30	Cr.-Wheeler	SC	1200
30	Gen. Elec.	KT342	720
25	West.	CS4730	1800
25	Rob.-Myers	K207	1800
25	Fynn-Weischel		1200
25	Gen. Elec.	KT336	600

197 Motors—¼ HP to 25 HP—all makes, speeds from 600 to 3600 RPM, including 2 speed and multispeed.

A.C. GENERATORS

2 and 3 Phase

150 K.W. Allis Chalmers, D.C. Exciter, 900 RPM.
112.5 K.V.A. G. E. ATB, 1200 RPM.
100 K.W. Gen. Elec. 900 RPM.
100 KVA G. E. ATB, 900 RPM.
90 K.W. Gen. Elec. 900 RPM.
75 KVA Westinghouse, 900 RPM.
85 K.W. Westinghouse, 720 RPM.
75 KVA G. E. ATB, 1200 RPM.
75 K.W. G. E. ATB, 1200 RPM.
60 K.W. G. E. ATB, 1200 RPM.
50 K.W. G. E. ATB, 720 RPM.
30 KVA Westinghouse, 1200 RPM. 1 phase generator, 3 phase motor.
25 K.W. Crocker-Wheeler, 1200 RPM.
30 KVA Westinghouse, 1200 RPM, 17 other A.C. generators also in stock.

2 and 3 Phase

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5000 and 700 KW. Condensing
400 KW. Non-Condensing
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BOILERS-PUMPS

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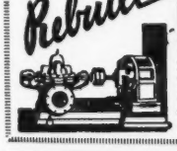

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3—125 hp. General Electric explosion proof induction motors. 3 ph. 60 cy. 550 V. 3500 RPM.

2—150 hp. Crocker-Wheeler type SC induction motors. 3 ph. 60 cy. 550 V. 3500 RPM.

1—DeLaval Centrifugal Compressor 7500 cu. ft. per min. at 3500 RPM., pressure 15 in. water.

Steam Pumps in stock from 3x2x3 to 20x16x12; Boilers, vertical, horizontal, water tube.

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3 Phase, 60 Cycle, Driving Motors

3—75 kw Gen. Elec. DLC, 110 volt, 1200 rpm
1—90 kw Gen. Elec. RC-36, 110 volt, 1200 rpm
1—30 kw Crocker-Wheeler
1—75 hp Gen. Elec. DLC, 230 volt, 1200 rpm
3—30 kw Westinghouse, SK, 230 volt, 1200 rpm

Slip Ring Motors with Control

1—125 hp Gen. Elec. IM, 450 rpm, 220/440 V
1—150 hp Gen. Elec. IM, 15A 900 rpm, 220/440 V
2—100 hp Gen. Elec. IM, 15A 514 rpm, 220/440 V
1—100 hp Allis Chalmers, any, 1800 rpm, 220/440 V
1—75 hp Gen. Elec. I-M, 720 rpm, 220/440 V
1—75 hp Allis Chalmers, any, 1800 rpm, 220/440 V
2—50 hp Westinghouse, HE, 900 rpm 220/440 V

We have hundreds of small motors, all types.

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6000 kw. 80% PF. West. Cond. rebladed completely rewound with Jet Cond.
2—5000 kw. West. 80% PF. Imp. & Reac. Cond. or Bleeder with Surf. Cond.
2—4000 kw. West. 80% PF. Imp. & Reac. Cond. or Bleeder with Surf. Cond.
3125 kva. West. Imp. & Reac. Cond. or Bleeder stand char. with Jet Cond.
2500 kw. G.E. Curtis Cond. and Bleeder rebladed completely overhauled.
2—1000/1500 kva. West. Cond. & Bl. stand. char. one Jet & one Surf. Cond.

TURBOS 25 CY

12000 kw. G.E. Rigid Frame Cond. with Surf. Cond.
2—10000 kva. West. Imp. & Reac. Cond. with Surf. Cond.
2—2000 kw. West. Cond. with Jet Condensers.

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4—1600 hp. B.&W. Cross Drum 350 lb. ASME Code West. Stoker equipped.
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5—2300 hp. Stirling ASME 210 lb. Superheater and Taylor Stoker equipped.
2—8000 hp. Edgemore Steel Header 3000 lb. ASME.
12—520 B.&W. Long Drum Steel Header 225 lb.

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2—3500 kw. G.E. & West. 60 cy. 250v. D.C. Syn. Rotaries.
2—1500 kw. 250v. D.C. MGS.
1—2000 kw. 600v. D.C. MG.
3—1000 kw. G.E. MGS. 60 cy. 250v. DC.

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1—7500 kw. Freq. 62½/25 cy. or 60/24 cy. 750 r.p.m.
3—5500 kva. Freque. 62½/25 cy. 750 r.p.m.
2—2000 kw. 80% PF. 60/25 cy. 300 r.p.m.
2—700 kw. 62½/25 cy. 750 r.p.m.

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Both 25 and 60 cy.

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1—50 HP JAMES SPEED REDUCER 685 to 101.5.
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4—30 HP AW10 P & H MOTORS 3 phs. 60 cycle, 440 Volts. 1200 RPM. Good Condition.
2—3000 KW GENERAL ELECT. TRANSFORMERS. New, never used. 5000/5 Amps.
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1500 KW. **Busch Sulzer** complete **Diesel** plant.
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3—75 H.P., 720 rpm., 3 ph., 60 cy., slip-ring motor.
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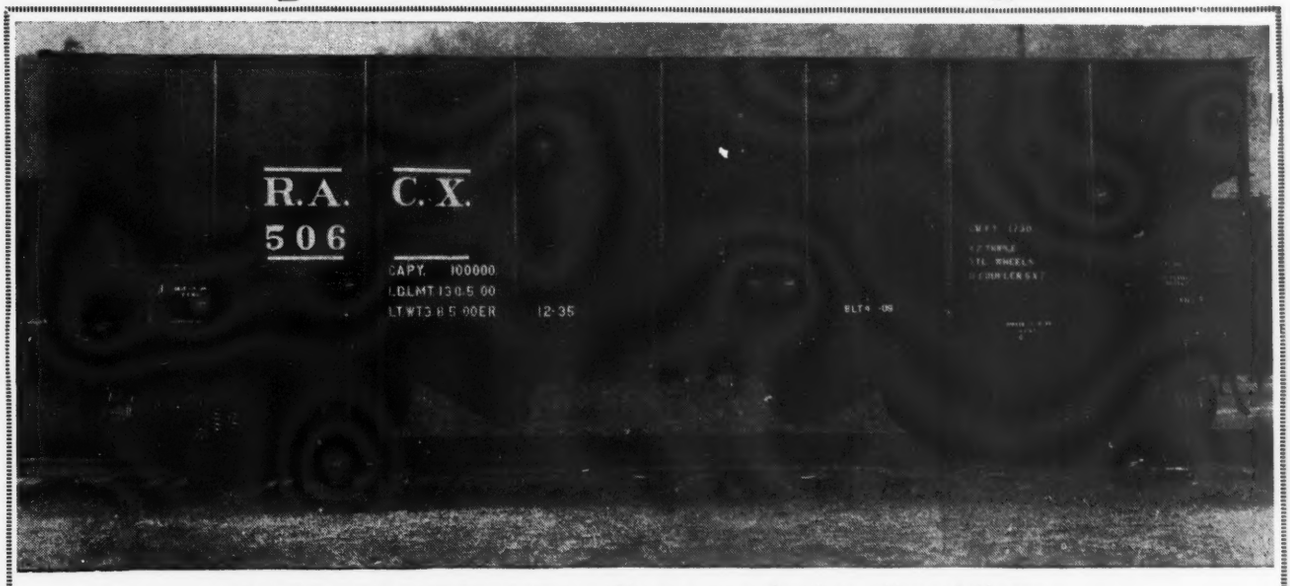

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1—220 v. d. c. driven TUEC vacuum cleaner.

Dallas Morning News
Dallas, Texas

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3386

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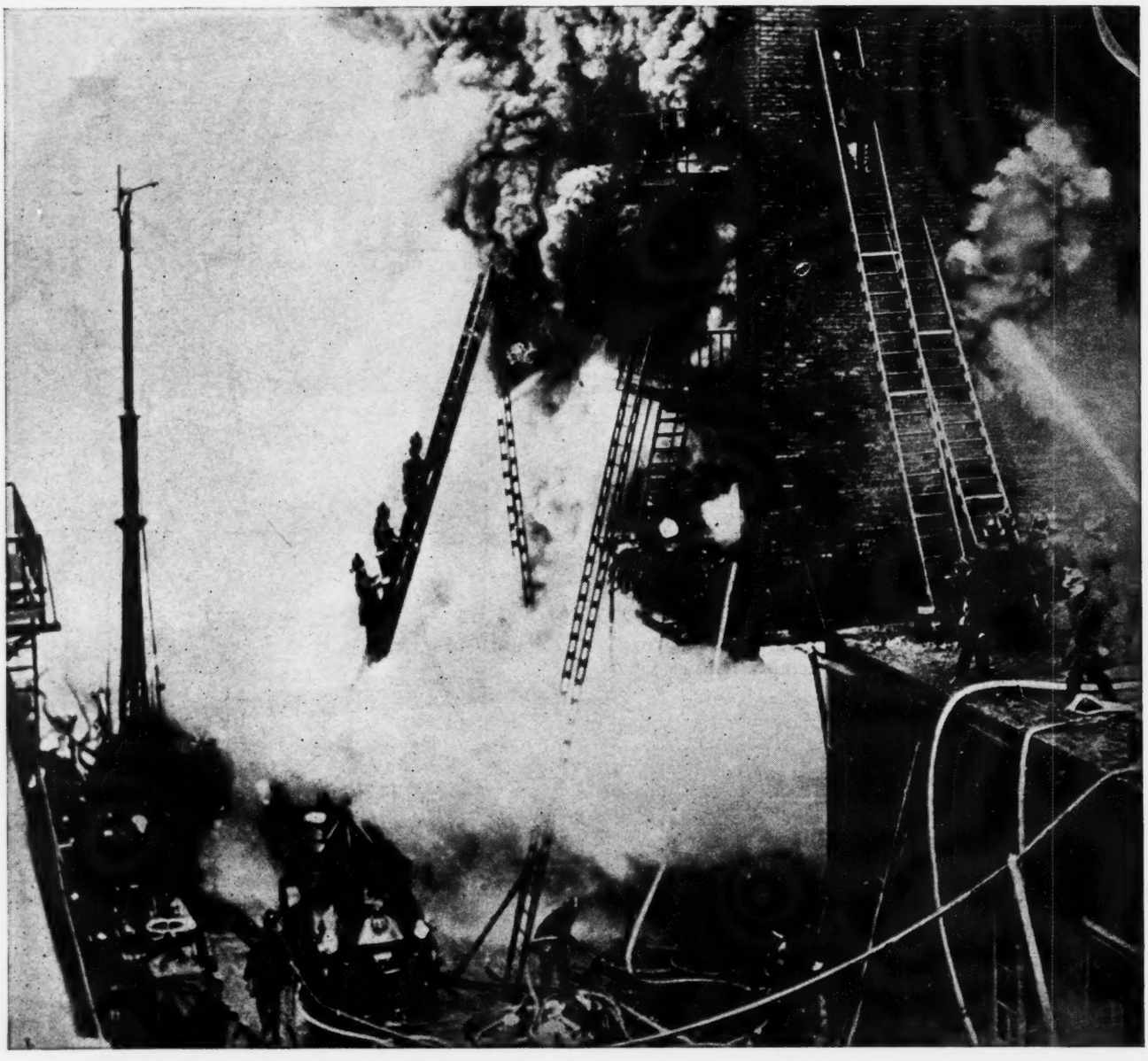

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